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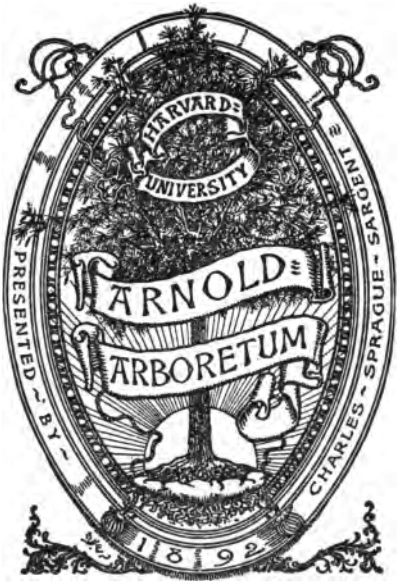
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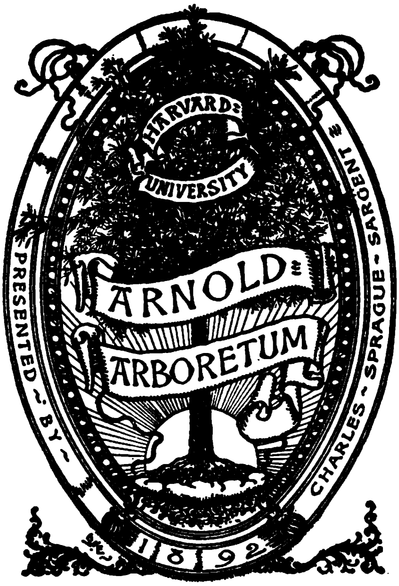
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# FARMERS' HAND BOOK OF EXPLOSIVES

DU PONT

# Explosives Service

FOR more than 120 years it has been the constant aim of the du Pont Company to deliver explosives where they are needed—*when* they are needed. Today this aim has been achieved by a system of mills and magazines, strategically located near practically every great industrial district.

* * * * * *

Prompt delivery is but one factor of du Pont service. We aim to see that our customers use the kind of explosives that will give the best results for their particular work at least expense—and that they are handled, stored and used most efficiently.

* * * * * *

In short, du Pont service is the result of a sincere effort on the part of the du Pont Company to meet and follow the demand, and to pass on to the users of their products, in a practical way, the results of their 120 years of experience and research in the manufacture and use of explosives.

* * * * * *

When you buy from du Pont, you buy more than explosives; you buy du Pont service.

E. I. du Pont de Nemours & Co.
INCORPORATED
Wilmington, Delaware

# FARMERS' HAND BOOK OF EXPLOSIVES

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# Farmers' Hand Book of EXPLOSIVES

DU PONT

Instructions in the Use of Explosives for Clearing Land, Planting and Cultivating Trees, Drainage, Ditching, Subsoiling and other Purposes

E. I. du Pont de Nemours & Co., Inc.
*Explosives Department*
WILMINGTON DELAWARE

[illegible]

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Sept. 14, 1923

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E. I. du Pont de Nemours & Company, Inc.
Wilmington, Del.

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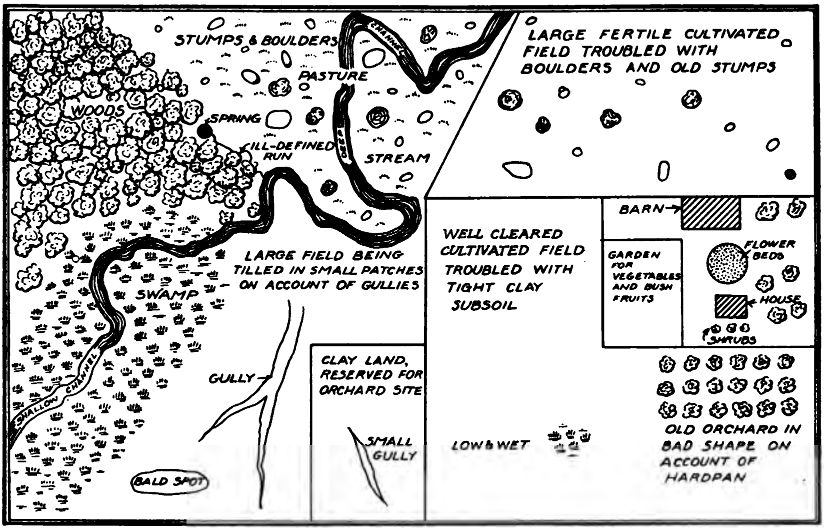
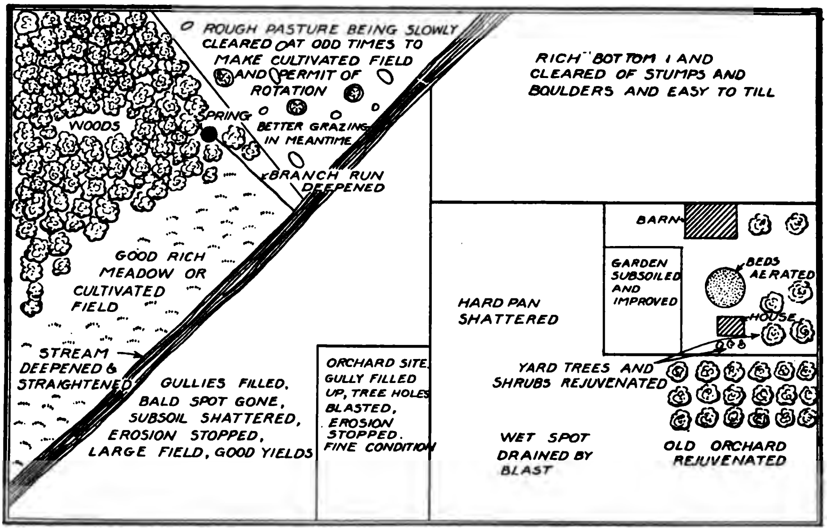
A-1319* Oct. '22

# The Function of Explosives in Agriculture

For many years lands were cleared, drained and tilled entirely by human labor and hand or horse-driven implements, but recently large tracts have been brought under cultivation much more quickly than was once thought possible by the employment of two new agents—explosives for clearing and draining and motor-driven machinery for preparing and tilling the soil. For farming on a large scale motor equipment is now considered essential, and explosives are recognized as efficient and economical both for the development of new lands and for the improvement of existing farms. Some of the purposes for which explosives may be advantageously employed in agriculture, the particular explosives adapted to these purposes, and the methods of using them are the subject of this book.


STUMPS & BOULDERS
CHANNEL
LARGE FERTILE CULTIVATED FIELD TROUBLED WITH BOULDERS AND OLD STUMPS
PASTURE
WOODS
SPRING
ILL-DEFINED RUN
DEEP
STREAM
BARN
WELL CLEARED CULTIVATED FIELD TROUBLED WITH TIGHT CLAY SUBSOIL
GARDEN FOR VEGETABLES AND BUSH FRUITS
FLOWER BEDS
HOUSE
SHRUBS
LARGE FIELD BEING TILLED IN SMALL PATCHES ON ACCOUNT OF GULLIES
SWAMP
SHALLOW CHANNEL
GULLY
CLAY LAND, RESERVED FOR ORCHARD SITE
SMALL GULLY
LOW & WET
OLD ORCHARD IN BAD SHAPE ON ACCOUNT OF HARDPAN
BALD SPOT

THE UNDER-SIZED FARM, SHOWING HOW THE PRODUCTIVE AREA IS REDUCED BY DEFECTS BLASTING CORRECTS.


ROUGH PASTURE BEING SLOWLY CLEARED AT ODD TIMES TO MAKE CULTIVATED FIELD AND PERMIT OF ROTATION
RICH BOTTOM LAND CLEARED OF STUMPS AND BOULDERS AND EASY TO TILL
WOODS
SPRING
BETTER GRAZING IN MEANTIME
BRANCH RUN DEEPENED
BARN
GOOD RICH MEADOW OR CULTIVATED FIELD
GARDEN SUBSOILED AND IMPROVED
BEDS AERATED
HARD PAN SHATTERED
HOUSE
STREAM DEEPENED & STRAIGHTENED
GULLIES FILLED, BALD SPOT GONE, SUBSOIL SHATTERED, EROSION STOPPED, LARGE FIELD, GOOD YIELDS
ORCHARD SITE GULLY FILLED UP, TREE HOLES BLASTED, EROSION STOPPED, FINE CONDITION
YARD TREES AND SHRUBS REJUVENATED
WET SPOT DRAINED BY BLAST
OLD ORCHARD REJUVENATED

THE FULL-SIZED FARM, GIVING THE ENTIRE AREA OF PRODUCTIVE LAND AFTER IMPROVING WITH EXPLOSIVES.

# The Under-Sized Farm

Every possible acre of a farm should be used to its maximum capacity. The few acres of waste land on any one farm are a loss to the individual farmer, and the total of these patches throughout the country, enormous in the aggregate, is of most serious concern to the entire nation.

The causes of waste land usually are: stumps, boulders, wet spots, gullies, and hardpan. The sketches on the opposite page show how these troubles reduce the workable size of the farm, and how the removal of them produces a full-sized farm.

Stumps cause "loafer land" by taking up space in the fields, by prohibiting economical cultivation, and by making breeding places for weeds and crop pests. They make the farm unsightly. Our sketch shows them encumbering the most fertile field on the farm, and preventing the bringing of the back pasture into the rotation.

Boulders cause the same troubles in general as stumps, and are shown assisting the stumps in dwarfing our farm.

The overflow caused by the shallow, crooked stream channel takes away more of the farm's good land and replaces it with a swamp that breeds disease and does not even afford good pasture. The spring and its shallow outlet make this condition still worse.

A part of the back fields is gullied and cut up into small patches that cannot be handled successfully. The fertile surface has been washed away. The bald or galled spots will not produce because there can be no storage of moisture and no humus.

The tight clay or hardpan cuts off the under side of the farm, reducing the productive size by taking away the third dimension—depth. It reduces yields of field crops and kills or stunts the trees.

In one feature or another our farm is typical of practically every farm. It looks unsightly and is only one-third efficient in crop production, and our aim is to change this farm to a full-sized one; to obtain the use of all the land, to make possible large fields, good crops, a good orchard, and a bounteous garden with an attractive house.

We naturally begin with the easiest places. The otherwise good bottom has but to be rid of stumps to make it conform to the highest ideals of the owner. These stumps are old and dead, and but small charges of explosives are required to dispose of them.

The gullies and bare spots in the big field follow next. A line of lightly loaded charges will tumble the soil into the gullies and so nearly fill them that they can be plowed across and brought into actual cultivation. Subsoil shattering and a coating of manure will revive the bald spots and the rest of the hardpan. The field is then all ready for the green manure crop to fit it for a fruitful orchard and good crop-yielding land.

With these two big fields in good condition, attention is turned to drainage, and the water from the wet spot back of the house disappears through crevices blasted into the underlying ground. A blast from a long line of loaded holes makes a fine straight channel for the creek, and a line of lighter loads lowers the spring branch so that all of the fertile swamp becomes field or meadow.

Spare hours spent in blasting the yard, garden, and old orchard enliven flowers, trees, and vegetables, and lay the foundation for future good years for each of them.

When all else is done the rough old pasture can be attacked as opportunity arises. When the stumps and boulders are all gone, the once unsightly spot can be brought into the regular rotation.

# Explosives for Farm Use

Blasting explosives are divided into two classes: high explosives and low explosives. High explosives, of which the most commonly known is dynamite, include those which can be properly fired or detonated only by means of an intermediate agent, such as a blasting cap or electric blasting cap, and not by simple ignition. Low explosives, such as blasting powder, are exploded by a spark.

## Blasting Powder

Blasting powder is produced in granulations or grains of various sizes. It is packed in bulk in steel kegs containing twenty-five pounds. Although it is invaluable for many kinds of coal mining, quarrying, and general excavating, it is not generally applicable to blasting about the farm except for splitting logs for timber or rails. For this work blasting powder is fired by means of safety fuse or electric squibs.

KEG OF BLASTING POWDER.

## Dynamite

Dynamite differs from blasting powder in that it is more powerful, detonates with much greater rapidity, and has a greater shattering effect.

The most important properties which contribute to the effect of dynamite are strength, or disruptive power, and quickness, or shattering power. Other properties which have some bearing on the usefulness of dynamite, as well as on the safety with which it can be handled, are its sensitiveness, stability, or power of keeping, and resistance to cold and to water.

The production of explosives which will possess these properties in the correct proportion requires long experience, skillful labor and supervision, the highest quality of ingredients, complicated and expensive machinery, and the continual testing of these ingredients, processes, and finished products. The du Pont Company has been engaged in the manufacture of explosives since 1802. It has factories in many parts of the United States. No other explosives manufacturing concern in this country maintains a greater number of technical chemists than are engaged at the du Pont laboratories. These chemists are employed in testing the daily output of the factories to prevent deviation from standards, and in studying and experimenting with explosives in order to improve them. They also give much time to developing explosives which are especially adapted to particular classes of work.

A corps of experts in the use of explosives is also maintained, not only to study the exact requirements of explosives in the various fields and under widely differing conditions, but to demonstrate their qualities, action, and use.

Dynamite is a solid, closely resembling fine, slightly greasy sawdust, and derives its explosive power from different compounds of nitrogen. It is packed in cartridges of heavy paraffin-coated paper. The standard size of cartridges is 1¼ x 8 inches, each cartridge weighing approximately a half pound. Shipment is made in tight wooden cases which contain either twenty-five or fifty pounds (net) of dynamite. Where possible, users should buy by the case, as a better price can be obtained. Shipments are made in 25, 50, 75, 100, or other multiples of 25, pound lots.

CASE OF DYNAMITE.

Responsible people can use and handle dynamite just as safely as they can handle gasoline, matches, or coal oil. The energy of dynamite can be directed for blasting purposes as well as the energy of steam can be directed for the work for which it is used.

There are many different kinds of high explosives manufactured for the various blasting operations. The particular kinds adapted for the several types of agricultural work are described in the following paragraphs. In some cases it will be noted that two or more explosives are recommended for the same class of work. This arises from the fact that practically all grades of du Pont explosives are very elastic in their adaptations and can be relied upon for many different classes of work.

In selecting for a particular class of work, use the explosive especially recommended, but in ordering small amounts for a number of purposes get the one best adapted to them all.

## Red Cross Farm Powder

This is a slow-acting, low-freezing powder especially adapted and manufactured for subsoil blasting, tree planting, gully filling, loosening soils for road grading, and stump and boulder blasting on heavy soils. It is not recommended for stump blasting on sandy and other loose soils. This explosive was developed especially for farm use.

CARTRIDGE OF RED CROSS FARM POWDER.

## Red Cross Extra 20 to 60 Per Cent. Dynamite

Like other Red Cross brands, it has the advantage of being low freezing. It is suitable for difficult stumping, ditching in dry soil with a blasting machine, boulder blasting (except mudcapping), pond drainage, ice blasting, tree felling, road grading, digging post holes, blasting very hard subsoils; in short, it is a general all-around explosive that can be used for many classes of work. However, the special brands recommended for certain classes of work should be used when possible.

## Dumorite

Dumorite is a more recently developed explosive which gives excellent results in most classes of work for which Red Cross Farm Powder and Red Cross Extra, up to and including the 40% strength, are recommended; that is, for all kinds of agricultural blasting except ditching by the propagation method or other very wet work. It gives as good execution with equal or smaller charges in practically all types of soil. As Dumorite is a bulkier explosive than the Red Cross Extra powders, running about one-third more cartridges to the fifty pound case, and is loaded on a cartridge basis in comparison with them, not a weight basis, it is considerably cheaper. In addition to being the most economical explosive available for agricultural work, Dumorite has two other distinct advantages in use. It does not freeze and it does not produce headache from handling. In order to obtain the best results with Dumorite it is essential that the primer be carefully made according to the method illustrated on page 24, that the primer be loaded last with the closed end of the cap pointing toward the bulk of the charge, and that the hole be well tamped.

## Repauno Stumping Powder and du Pont Stumping Powder

These are low-freezing explosives manufactured to meet the stumping conditions encountered in the Pacific Northwest. They are also recommended for shattering hardpan and planting trees. They should be handled in the same way as the Red Cross explosives. They are not sold in the East.

## Pacific Stumping Powder

This is an explosive of the Dumorite type especially adapted to stump blasting in the Pacific Northwest and sold only in that district. It gives results at least equal to those secured with the older stumping powders listed above and at approximately half the cost, for the 1¼ x 8″ size of Pacific Stumping Powder, running 130 cartridges to the fifty pound case, can be loaded stick for stick against the generally used 1⅜ x 8″ size of the standard stumping powders which run about 85 cartridges to the fifty pound case. Pacific Stumping Powder is a non-freezing, non-headache explosive. The same practices should be followed in using it as recommended for Dumorite.

## Du Pont Straight 50 Per Cent Dynamite

This explosive is quicker and more shattering in its action than the Red Cross brands. In agricultural work it is especially adapted for blasting ditches in wet soils by the propagation method (that is, without a blasting machine), for mudcapping hard boulders where there is much work to be done, and for digging deep post holes. It is more sensitive to shock than are the Red Cross brands, and requires more careful handling. It is low freezing. It resists water well and can be used in wet work.

## Du Pont Gelatin

This dynamite is more plastic than the others. It is low-freezing, and resists water to a marked degree. The 40 per cent. strength is well adapted to blasting ditches in sandy or loose material, and to work where charges must be under water for a long time.

# Handling Explosives

## Hauling

The law requires prompt removal of explosives and blasting accessories from freight stations. Persons expecting shipments should arrange with the freight agent or station master to be notified immediately of the arrival of the explosives and should remove them within twenty-four hours.

When transporting explosives by team, always keep the wagon boxes thoroughly swept. When using an open wagon, protect the load from sparks and rain with a robe or canvas cover. Lay the cases of explosives flat, in such a way that they will not shift. Never haul detonators and explosives together. The detonators do not weigh much, and can be brought along on some other trip. If blasting caps are purchased from a dealer, in the tin boxes separate from the wooden shipping case, it is a good plan to put these boxes in a basket or wooden box packed with a horse blanket, coat, hay, or anything that will keep them from being roughly jarred and shaken on the way home.

## Storing

As soon as explosives are received they should be stored in a dry, properly ventilated building, safe from fire and flying bullets, and far enough away from dwellings or roads to prevent loss of life should they be accidentally exploded. They should be kept under lock and key, where children or irresponsible persons cannot get at them.

If large quantities are to be stored for some time, a dry, well-ventilated, fire-proof, and bullet-proof magazine located in an out-of-the-way place should be provided. Fuse, wire, thawing kettles, and blasting machines may be stored in the same building with the dynamite, but blasting caps and electric blasting caps must never be stored in the same building, because they are more easily exploded than dynamite. It would be possible to explode them accidentally by a hard shock or jar which would not explode dynamite. If detonators were to explode by themselves, they would not be likely to do much damage unless there were a great many of them, but if they were to explode in the same room with dynamite, they would probably cause the dynamite to explode also.

## Using

When ready to use the dynamite, open the box or case with a hardwood wedge and a mallet. Never take more than the day's supply to the work, even in warm weather. In cold weather, take only as much as can be kept thawed until it is to be used, unless there are arrangements for keeping it thawed where the blasting is to be done.

When quantities of high explosives, other than Dumorite, are handled with bare hands, they often cause a headache. Cheap cotton gloves should therefore be worn. The gloves should be destroyed before they become damp and sticky, and clean ones provided.

When possible the holes should all be ready before the dynamite is brought to the work. As soon as they are ready, the priming, charging, tamping, and firing should be carried on as rapidly as is possible without causing carelessness or confusion. A little practice will teach the blaster to do his work quickly, systematically and economically.

## Thawing

Some kinds of high explosives freeze at about 55 degrees Fahrenheit. The different low-freezing explosives, however, will not freeze until the weather is quite cold, and Dumorite is absolutely non-freezing.

Frozen dynamite is easily recognized because it is hard and rigid. When in this condition dynamite detonates imperfectly, if at all. Even when only chilled, it cannot be depended upon to work well. It must be thawed before it is used.

If, after the thawed dynamite is ready to use, something causes a delay and it becomes chilled or frozen before it can be put into the bore hole, it should be thawed again. It does not harm dynamite to thaw it many times, provided the thawing is correctly done.

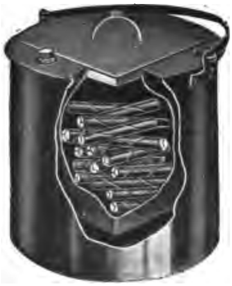
High-freezing explosives are likely to chill or freeze almost immediately when loaded in cold ground, and it is therefore necessary to detonate them immediately after charging. But low-freezing explosives if loaded in the ground below the frost line and properly tamped, will not freeze unless the temperature falls so low as to drive the frost in the ground down to the charge before it is fired. This power to resist cold makes the low-freezing explosives and the non-freezing Dumorite invaluable in cold weather.

Dynamite can be thawed by leaving it spread out on a shelf in a warm room (not in a dwelling) over night, or by burying it, while in the case, in green manure (see cut on page 14). It may be thawed also by putting it in a covered, water-tight pail and hanging this pail in warm water. It is exceedingly dangerous to try to thaw dynamite in front of an open fire, in hot sand or ashes, on hot stones or hot pipes, in an oven, or in hot water or steam. More accidents are caused by careless thawing than in any other way.

The best way to thaw dynamite, and to keep it thawed until it is to be used, is in a thawing kettle made for the purpose.

Du Pont thawing kettles are all made in one piece, with a water-tight compartment for the explosives, which is surrounded by the receptacle for the hot water used to furnish the heat for thawing. This hot water must not come in contact with the dynamite.

While du Pont thawing kettles will retain their heat and keep the explosive thawed for a considerable time, depending, of course, on the nature of the weather, this period can be increased to about five times as long if the warm kettle is kept in a barrel or box with



DU PONT THAWING KETTLE.

dry hay surrounding it. The hay can be held in place by a cylinder of wire screen, so that the thawing kettle can be easily removed and replaced. If the barrel be mounted on two wheels with a tongue attachment, the dynamite can be readily drawn from point to point about the outside work, so that it need not be exposed to the cold air until it is to be loaded in the bore hole. Wrapping old blankets or sacks around the warm kettle will also keep the dynamite thawed for a longer period.

Under no circumstances must the water be heated in thawing kettles, even though the explosives be first removed, because nitroglycerin may exude from warm dynamite, and enough of it is likely to be found in the bottom of the explosives compartment of a thawing kettle that has been in use for some time to cause a serious accident if the thawing kettle should be placed over a fire. It is necessary to heat the water in something else before filling the water jacket. The hot water must always be tested before filling the dynamite compartment. If it is hot enough to burn the hand, do not put the explosives into the thawing kettle. Never fill the water jacket unless the explosives compartment is empty. See that the explosives compartment is perfectly dry before it is filled.

Thawing kettles should be kept clean at all times. Should any of the explosive compounds leak out the explosives compartment should be thoroughly cleaned with a solution of sal soda.

**Table of Sizes of Thawing Kettles**

| | Capacity | Weight Empty | Weight of Water | Total Weight Filled | Outside Dimensions |
|---|---|---|---|---|---|
| Du Pont No. 1........ | 30 lbs. | 12½ lbs. | 40 lbs. | 82½ lbs. | 14" x 14½" |
| Du Pont No. 2........ | 60 lbs. | 17½ lbs. | 77½ lbs. | 155 lbs. | 17½" x 21" |

The use of thawing kettles can be done away with to a large extent, by using low-freezing explosives, such as Red Cross Extra Dynamite, du Pont Straight Dynamite and du Pont Gelatin, or entirely done away with by using Dumorite.

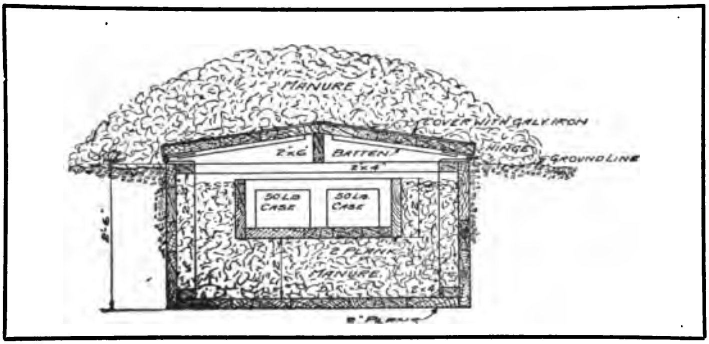


FIG. 1. A PERMANENT MANURE THAWING BOX FOR DYNAMITE CAN BE EASILY BUILT ACCORDING TO THESE PLANS.

# BLASTING ACCESSORIES

For firing charges of explosives certain accessories are needed. If the charge is fired by electricity, electric blasting caps, a blasting machine, and leading wire are necessary. Otherwise, blasting caps, safety fuse, and a cap crimper are used.

## Du Pont Blasting Caps

Du Pont blasting caps, used for firing or detonating charges of high explosives, are the big brothers of the primers in a gun shell—many times bigger. The No. 6 cap, which is the size recommended for detonating most high explosives, is a copper cylinder 1½ inches long and a little less than ¼ inch in diameter, closed at one end, and loaded with 1 gram (15.4 grains) of a fulminating mixture. The No. 8 size is longer and contains a 2-gram charge. Nothing smaller than a No. 6 should be used with any of the explosives used on the farm because strong caps:

Insure complete detonation.
Increase the execution of the explosive.
Offset, to some extent, deterioration,
  due to improper storage.
Prevent the loss of the charge by burning.
Minimize the fumes.

No. 6 DU PONT BLASTING CAP.

BOX OF DU PONT BLASTING CAPS.

Blasting caps are packed in tin boxes containing 100 caps. From 5 to 50 boxes are packed for shipment in wooden cases. They may be exploded by shock, heat, or sparks, and so must be kept away from fire and always be handled carefully. They are weakened by moisture and therefore must be stored in a dry, cool place.

Blasting caps are used only in connection with safety fuse. They must be securely fastened to the fuse, and this is best done with a du Pont cap crimper such as is described on the following page.

## Fuse

Safety fuse consists of a thin train of powder, wrapped in several coverings of jute or cotton yarn or tape. It is used to bring a spark to a cap in detonating a charge of high explosives. Many grades are made for different purposes. In blasting on a farm, Charter Oak is generally used for dry or moist work and Clover for wet work. Clover is always best for use with Dumorite. Fuse is packed in a double roll, one fitting inside the other, each 50 feet long. Each double roll of 100 feet is wrapped separately. It is packed for shipment in wooden cases containing from 500 to 6000 feet.

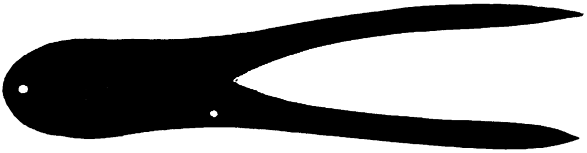
ROLL OF SAFETY FUSE.

Fuse should always be kept dry and should be stored in a cool, dry place. If stored in a damp place it becomes damaged after a time and may fail to burn. If stored in a hot, poorly ventilated place, as for example, close under the roof of a small shed, in summer time, it may be damaged either by becoming soft and oily or by drying out and becoming so hard and brittle that it will break when unrolled. Fuse may also become stiff and brittle in cold weather. When in this condition it should be warmed before being unrolled.

## Cap Crimpers

Du Pont cap crimpers are made especially for fastening caps to fuse securely and are necessary wherever blasting is done with cap and fuse. Other means of crimping which are sometimes used are unsatisfactory and dangerous.

The du Pont crimpers make a crimp which is so firm and of such a shape as not only to fasten cap and fuse together securely but also to be of aid in preventing moisture from penetrating into the cap. One style is supplied with a pair of jaws for cutting fuse. These crimpers are the result of years of experimentation, and are the best ever offered the public.

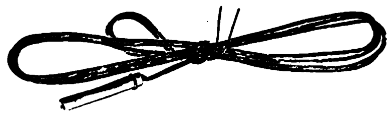


DU PONT No. 2 CAP CRIMPER.

## Du Pont Electric Blasting Caps

Electric blasting caps, like caps and fuse, are for detonating charges of high explosives. The explosive charge is contained in a copper cylinder similar to the blasting cap. The electric current brought along two copper wires heats a fine platinum wire imbedded in the charge, thereby causing the ignition of the charge in the electric blasting cap. In strength they are the same as the ordinary caps of the same number. The No. 6 strength is the one adapted to farm work.

It is only by the use of electric blasting caps that a number of charges can be fired at the same time. It is therefore absolutely necessary to use them in ditching in dry ground, in blasting large stumps and boulders, or in any other work where it is necessary to explode a number of holes simultaneously. Whenever used, electric caps reduce the chances of misfires, save time, eliminate delayed or premature explosions, and in a good many instances save dynamite.



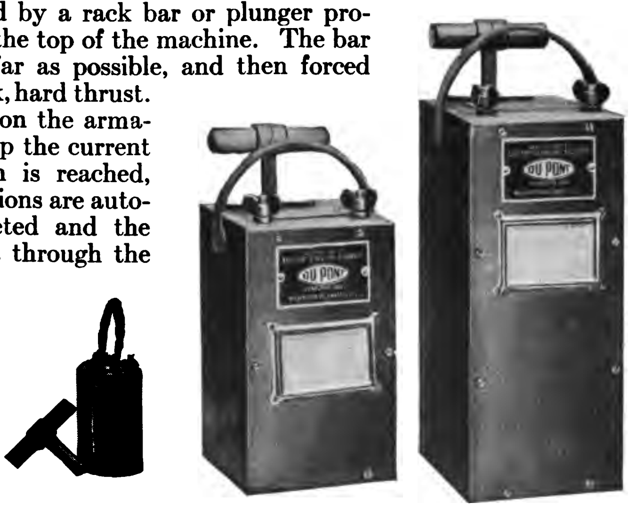
A DU PONT ELECTRIC BLASTING CAP SHOWING WIRES.

Du Pont electric blasting caps, like blasting caps, can be exploded by shock or heat. In handling and storing them, the same precautions as are given for blasting caps should be strictly observed. Never attempt to pull the wires out of their setting or investigate the contents of these caps.

The wires attached to the caps range in length from four feet to twenty feet, but it is seldom that anything longer than a four or six-foot length will be needed in farm work. These lengths are packed in lots of fifty in strong paper cartons. Ten cartons are packed in a wooden shipping case.

## Du Pont Blasting Machines

Du Pont blasting machines are small, portable electric generators* built for generating current to fire electric blasting caps. The mechanism is operated by a rack bar or plunger protruding through the top of the machine. The bar is pulled up as far as possible, and then forced down with a quick, hard thrust. This sets in motion the armature and builds up the current until the bottom is reached, when the connections are automatically completed and the current flows out through the leading wires to the electric blasting caps placed in the charges of explosives. The current is conducted from the machine to the blast by copper wires attached to the two wing-nut binding posts on the above machines.



Pocket Size No. 2 No. 3

RELATIVE SIZES OF DU PONT BLASTING MACHINES.

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*The pocket size is a magneto and is operated by twisting the handle.

When using the machine, the rack bar should be forced down as hard as possible, the operator using both hands and all his weight. The machine should be placed on a firm and level place so that it will not tip over or reduce the force of operation by being out of line.

These machines are built for rough use and every precaution is taken to make all parts strong. They are likely to be damaged, however, by exposure to the weather, and should be wiped off and put in a dry place when no longer in demand. They should be tested occasionally with a du Pont rheostat, to be sure that they are working up to standard capacity.

Du Pont blasting machines are built in six sizes so that a selection can be made to suit the demands of all classes of work.

**Sizes and Capacities of du Pont Blasting Machines**

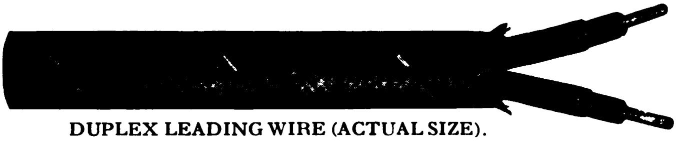
| Size of Machine | Capacity—Number of Electric Blasting Caps Copper Wire | Used for |
|---|---|---|
| Pocket | 1 to 3 | Stumping and boulder blasting. |
| No. 2 | 1 to 10 | Stumping, boulder blasting, and small ditch jobs. |
| No. 3 | 1 to 30 | All classes of general work. |
| No. 4 | 1 to 60 | Large ditches. |
| No. 5 | 1 to 100 | Large ditches. |
| No. 6 | 1 to 150 | Large ditches. |

For stumping, boulder blasting, loosening soils to assist digging, and similar work, the No. 2 machine will be found entirely satisfactory. Larger blasts having a greater number of charges will require a larger size, but the machines larger than No. 3 are seldom needed except on large contracting jobs. Even very long ditches can be blasted in sections with the No. 3 machine.

## Leading Wire

Leading wire is insulated copper wire used for conducting the current from the blasting machine to the blast. The du Pont leading wire has a strong insulation especially suited to the rough usage it must receive. It is sold in coils of 200 feet, 250 feet, 300 feet, and 500 feet. There are two kinds, single and duplex. In the duplex wire, the two wires are bound together. Single leading wire weighs about two pounds to the hundred feet, and duplex leading wire weighs four pounds to the hundred feet. Leading wire is sold by the pound. The double wire will be found most satisfactory for stumping and boulder blasting, and the single wire for ditching.

DU PONT LEADING WIRE.



DUPLEX LEADING WIRE (ACTUAL SIZE).

DU PONT CONNECTING WIRE.

## Du Pont Connecting Wire

Connecting wire is used to complete the circuit when the holes or charges are placed too far apart for the electric blasting cap wires to reach. It is sold in one and two-pound spools. A one-pound spool of No. 20 wire holds about 210 feet.

## Galvanometer and Rheostat

The du Pont Company manufactures an instrument for testing blasting circuits, called the du Pont galvanometer. This is an ingenious instrument of use in determining whether a blasting circuit will transmit the current, and also in locating breaks in the circuit. This company manufactures also a simple instrument used for testing blasting machines called a du Pont rheostat. For instructions as to the use of galvanometer and rheostat ask for our "Blasting Accessories Catalogue."

# Tools for Agricultural Blasting

Certain tools are needed for loading and making the bore holes. Those used for agricultural blasting are very few and simple. They are often to be found on the farm, but if not they can be quickly made at little cost by a blacksmith. An elaborate outfit is seldom required even on large jobs.

## Tamping Stick

A tamping stick is used to tamp the soil on top of the cartridges and to place the cartridges in the bore hole. It is also of use in trying out the holes before loading to see that they are properly placed, that they are of a sufficient depth, and not stopped up. It must be of wood, with no metal parts. Its length should be a little greater than the depth of the holes to be loaded, and its diameter not smaller than that of a cartridge of dynamite, 1¼ inches.

FIG. 2. HOME-MADE TAMPING STICK.

An excellent one can be made of an old hoe, rake, or broom handle, or, when a very long one is needed, from a sapling.

## Subsoil Punch

For driving holes for subsoil blasting and tree planting, for stumping, for ditching in hard soil, and for road grading, a subsoil punch is needed. It should be of 1½ inch round or octagonal steel, and a few inches longer than the depth of the holes. The point should be drawn out in the shape of a rather blunt pencil point. It is driven into the ground by means of heavy hammers or sledges, and loosened by pounding on the sides.

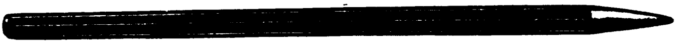


FIG. 3. STEEL SUBSOIL PUNCH.

## Spoon

A blasting spoon made by flattening and cupping the end of a ¼-inch steel rod, as shown in the accompanying cut, is very convenient for enlarging bore holes, removing pebbles from holes, and for removing tamping from misfired holes.

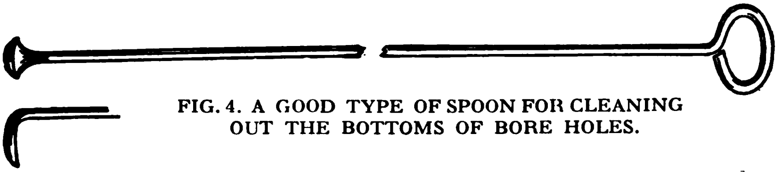


FIG. 4. A GOOD TYPE OF SPOON FOR CLEANING OUT THE BOTTOMS OF BORE HOLES.

In the course of his work, the agricultural blaster must make many holes in hard ground. The subsoil punch is undoubtedly the best tool for this purpose when the holes are not more than from thirty-six to forty-two inches in depth. When deeper holes are needed, the punch can be used to start the holes, and a good soil auger to deepen them. The use of a little water often facilitates punching and boring.

## Crowbar

A crowbar will be found convenient for making holes under stumps and boulders, for ditch blasting, and occasionally for subsoiling or tree planting.

A satisfactory crowbar for this work can be made out of an old buggy axle by cutting off one spindle and forging a wedge or chisel point.

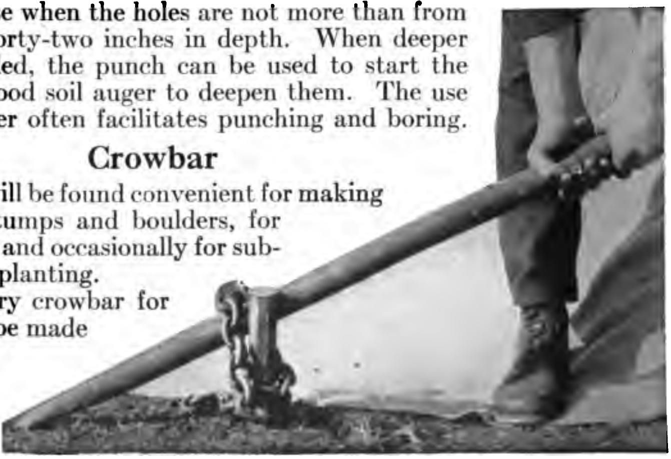


FIG. 5. WHEN THE SUBSOIL PUNCH CANNOT BE LOOSENED BY POUNDING ON THE SIDES NEAR THE GROUND, A CHAIN IS LOOPED AROUND THE TOP SO THAT A CROWBAR OR POLE CAN BE USED AS A LEVER.

## Soil Auger

The soil auger is used for making holes for stump and boulder blasting, for deep drainage, and for other holes hard to make with a punch. While it can be used for subsoiling it is not as fast as the subsoil punch. It should be 1½ or 2 inches in diameter.

The bit may be welded to a solid steel shank that will make the auger at least five feet long, if it is for stump or boulder blasting. For deeper holes the shank can be made of ⅜ or ½ inch gas pipe in sections of 2 or 3 feet in length, so that it can be extended by adding more sections. The handle is made of a pipe tee and two short pieces of pipe for grips.

A good type of auger head can easily be made by a blacksmith. The shank is flattened out and welded into a sleeve socket. The handle proper should be of wood and only long enough to make turning easy.

Worn-out wood augers make fairly good soil augers for small jobs, but where there is much work to do it will pay to get the special soil augers shown below.

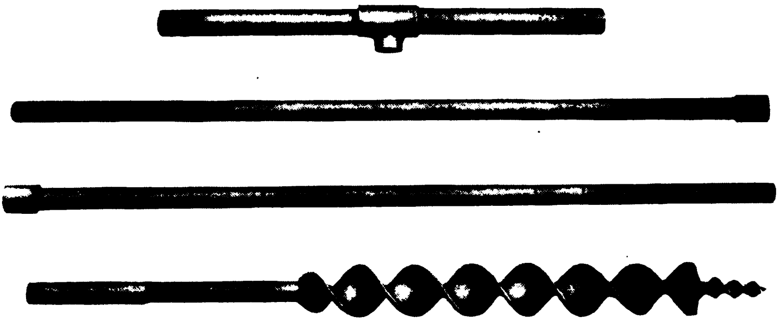


FIG. 6. SOIL AUGER WITH SECTIONAL HANDLE MADE OF THREE EIGHTHS INCH GAS PIPE.

## Wood Augers

Wood augers are used by the blaster for boring into the tap roots of fat pine stumps, and for log and stump splitting. They should be both heavy and sharp. For stump blasting the shank should not be less than five feet long.

## Other Tools

Heavy hammers are needed to drive the subsoil punch, and a mattock and shovel can be used for a number of purposes. For blockholing rock, a hand drill and hand hammer will be needed. For jobs where there is much rock drilling to do, the use of power drills is recommended. They are not needed, as a rule, on small jobs.

# Method of Blasting

Explosives are solids or liquids which can be changed instantaneously by a spark, great heat, or powerful shock into gases having many times the volume of the explosives in their original form. Likewise coal and wood are changed slowly into large volumes of gas by burning and water is changed into a large volume of gas (steam) by heating. This conversion of a substance into gases is the whole theory of explosives; and much in their use which otherwise seems difficult to explain is easily understood if this be borne in mind.

If the explosive is unconfined when detonated, the expanding gases will simply waste themselves in the air; but if the explosive is confined in a bore hole, the gases will exert a great pressure on the surrounding material to be blasted and, if strong enough, will shatter it or throw it into the air. The pressure exerted by the gases is, at the moment of explosion, equal in all direction. However they naturally tend to escape from their confinement by the easiest route, along the line of least resistance.

Therefore the best shattering of a material is obtained by placing the explosive in it and tamping the hole securely, so that the force is exerted on it equally in all directions. This is applicable to blasting soil, blockholing boulders, and splitting stumps. On the other hand when a boulder or stump is to be blown into the air, the charge should be placed directly below the object. If a hole is placed to the side of a stump, the gases are likely to blow out through the more easily lifted soil. In placing charges, the aim should always be to make the easiest way out directly through the material to be moved or broken. Care should also be taken to tamp the charge thoroughly. If the tamping is omitted or is insufficient, the tendency is for the gases to blow out through the bore hole.

## Priming

As has already been explained, dynamite is fired or detonated by means of the shock from a blasting cap or electric blasting cap, both of which are known as detonators. In order that the detonation may be complete, or in other words, that the full strength of the explosive be developed, the detonator should be placed inside a cartridge of the charge, with its closed or "business" end pointed toward the main bulk of the charge.

The placing of the detonator in the cartridge is spoken of as priming, and the cartridge containing the detonator as a primer.

The greatest care should always be exercised in making primers, for, if the work is carelessly or incorrectly done, the best results cannot be expected and the danger of accidents is increased.

## Priming with Cap and Fuse

There are two satisfactory and reliable ways of inserting a blasting cap and fuse in a cartridge, one, from the side of the cartridge, the other, from the end. The fuse should never be laced through the cartridge with either method.

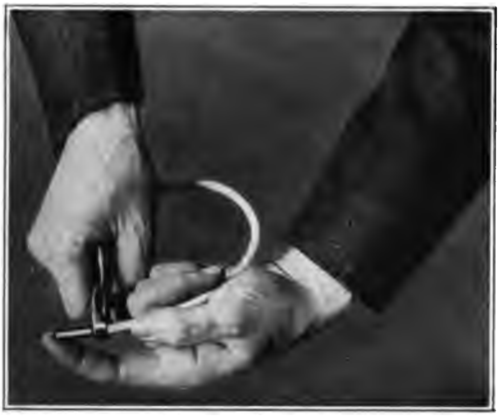


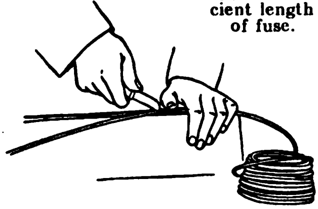
FIG. 7. CRIMPING A BLASTING CAP TO A PIECE OF SAFETY FUSE.

The first step in both methods is attaching the blasting cap to the fuse.

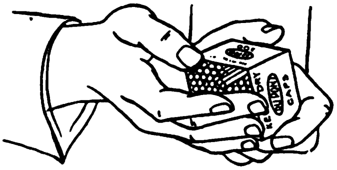
**Attaching Blasting Caps to Fuse.**—In doing this, the fuse should be cut long enough to give the blaster time to reach a safe place before the explosion. Fuse burns on an average of two feet per minute, and, in addition to allowing sufficient time, it should reach about three inches out of the bore hole.

Examine your dynamite and see that it is not frozen. Frozen dynamite is hard and rigid, and dangerous to handle; when thawed it is soft. Next examine your fuse; see that it is not stiff and brittle; if in this condition it is advisable to warm slightly. Cut the required length from the roll with a clean, sharp knife, hatchet, or cap crimper. The cut should be made squarely across and not diagonally (1, Fig. 8). Sometimes in the cutting the end becomes flattened, thereby making the end of the fuse too large to enter the blasting cap. When this happens, squeeze the end round with index finger and thumb or in the cap crimper. Open the cap box and allow one cap to slide gently out into the fingers (2, Fig. 8); but, under no circumstance, pick a cap out of the box with a piece of wire, stick, or other hard substance. See that there is no grit or trash in the cap. Slip the end of the fuse gently into the cap until it is against the charge in the bottom (3, Fig. 8). Do not twist the fuse, as the friction might cause a premature explosion. Then take the cap crimper and fasten the cap to the fuse with a crimp near the open end of the cap (4, Fig. 8). These operations are not dangerous, but should be done carefully. If the primer is to be used in a wet hole, dip it in du Pont Cap Sealing Compound, or smear a little hard tallow, soap, or similar substance around the top of the cap, to insure against water leaking in and ruining the cap before it is fired. Never use oil or light grease, as these will penetrate the fuse covering and ruin the powder in the fuse. The cap is then ready to be inserted into the dynamite.

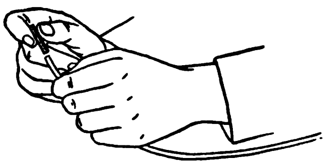
1. Cut off a sufficient length of fuse.



2. Take one cap from the box with the fingers.



3. Slip cap on end of fuse.



4. Crimp cap to fuse with cap crimper.

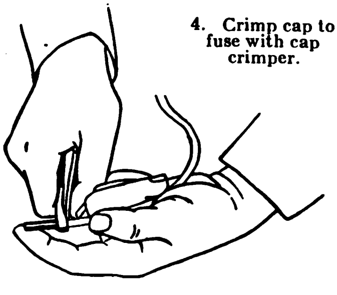
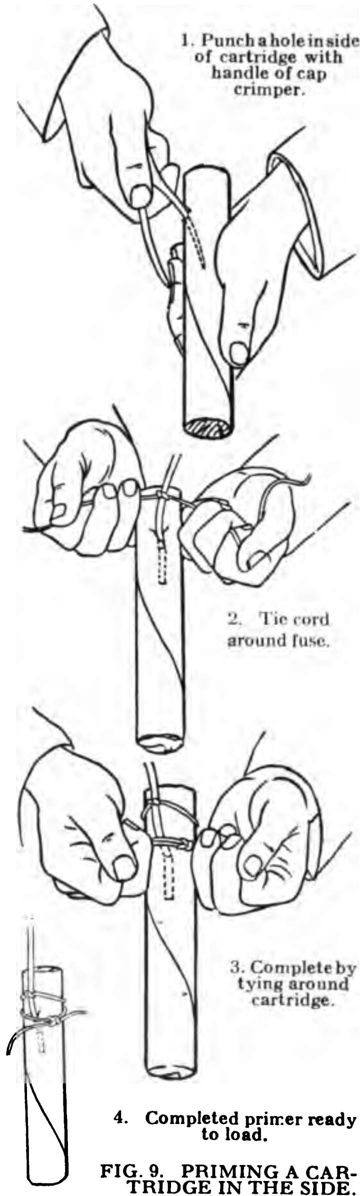


FIG. 8. ATTACHING A BLASTING CAP TO SAFETY FUSE.



1. Punch a hole in side of cartridge with handle of cap crimper.

2. Tie cord around fuse.

3. Complete by tying around cartridge.

4. Completed primer ready to load.

FIG. 9. PRIMING A CARTRIDGE IN THE SIDE. (A HIGHLY SATISFACTORY METHOD FOR MOST CLASSES OF AGRICULTURAL BLASTING.)

**Priming Cartridges in the Side.**—This is done by punching a hole diagonally into the side of the cartridge (1, Fig. 9) near the end and pointing toward the center, to a sufficient depth to receive the entire cap but none of the fuse above the cap. The holes can be punched with the handle of a cap crimper, or with a wooden awl. Insert the cap with fuse attached and tie it there with a piece of cord, winding the cord firmly around both the fuse and the cartridge (2, 3 and 4, Fig. 9). The cap should always be securely fastened to the cartridge so that it cannot become separated and cause a misfire.

This method has the advantage of leaving more space to place the tamping stick in seating the primer in the hole, but it is not so satisfactory as the end-primed cartridges for small holes, because the side-primed cartridges are slightly larger in diameter. It is the method generally used by agricultural blasters.

**Priming Cartridges in the End.**—This is done by punching a hole directly into the end of a cartridge (1, Fig. 10), through the paper shell, and to a sufficient depth to receive the entire cap. Into this, insert the cap with fuse attached and tie it securely as is indicated in 2 and 3, Fig. 10. The fuse above the cap should not extend into the cartridge.

This method has the advantage of making primers of the smallest possible diameter and of placing the cap in the best possible position; but it has the disadvantage of leaving little room for seating the tamping stick. It is largely used in blockholing boulders and other work where the bore holes are small.

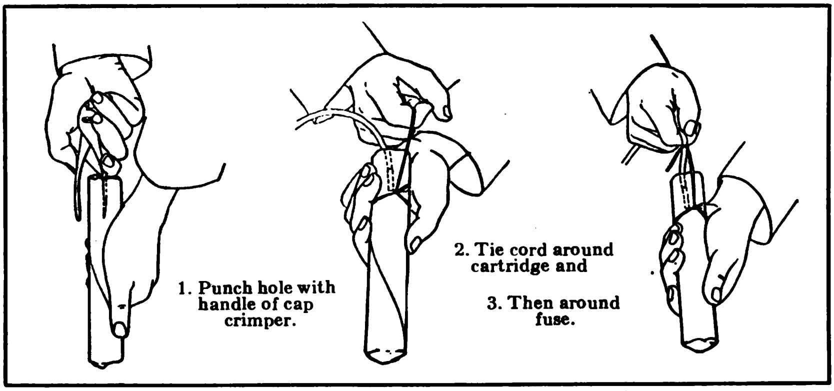

1. Punch hole with handle of cap crimper.
2. Tie cord around cartridge and
3. Then around fuse.

FIG. 10. PRIMING IN END OF CARTRIDGE.

## Priming with Electric Blasting Caps

When electric blasting caps are used they may be inserted into the dynamite by either of the methods described for caps and fuse. Many blasters, however, prefer to use a slightly faster method, which has been found entirely satisfactory.

Punch a hole from the center of the end of the cartridge in a slanting direction so that it will come out at the side 2 or 3 inches from the end, insert the end of the doubled-over wires of the electric blasting caps, loop these around the cartridge, and punch another hole in the top a little to one side of the first and straight down. Insert the entire capsule in this last hole, and take up the slack on the wires. You then have a primer where the wires do not cross each other at any point, the capsule is lying nearly in the axis, and the cartridge hangs vertically so that it is possible to load in the bore hole without its being caught on any roughness.

Never half-hitch the wires around a cartridge, for when the wires are pulled or the primer lowered into the bore hole, the insulation may become worn through where the wires cross, thus allowing the bare wires to come in contact. If this happens, it causes a short circuit and a misfire.

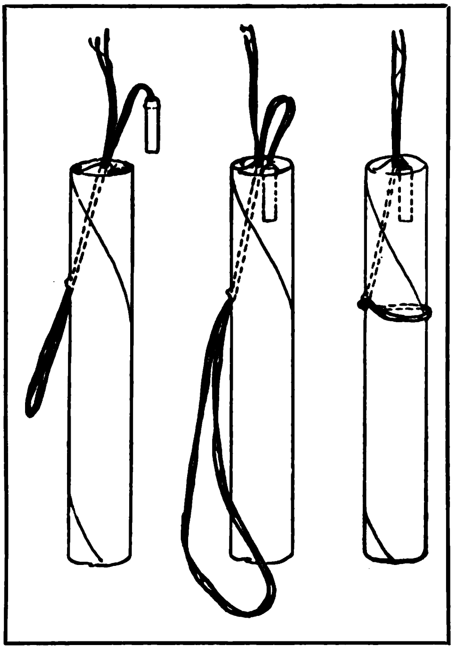


FIG. 11. A QUICK METHOD OF MAKING PRIMERS WITH ELECTRIC BLASTING CAPS.

## Priming Half-Cartridges

When small charges are used, as in subsoiling, the primers are sometimes made of half cartridges. In this case, it is good practice to punch a hole in each end of the cartridge and cut the cartridge in two before inserting the cap. The cartridge should be cut with a sharp knife. Hold the cartridge firmly in one hand and the knife in the other. Giving the cartridge a rotary motion, cut the paper all the way around, and then bend the cartridge slightly and it will come apart just where the paper is cut. Never try to cut a frozen cartridge.

CUTTING CARTRIDGES IN HALF.

## Making Bore Holes

The holes made for loading explosives are called bore holes. These should be prepared before the primers are made. The tools described on pages 19 to 21 are found most useful for making the different kinds of bore holes. Specific advice with regard to their location and depth is given in the descriptions of the different classes of blasting.

## Loading

When the cartridge is primed and the bore hole made, the next thing to do is to load. First try the hole with the tamping stick to see that it is open and will permit the charge to be placed at the desired point.

When loading a charge consisting only of the half or whole cartridge containing the detonator, as in subsoiling or tree planting, start the primed cartridge into the bore hole and press it gently into place with the tamping stick. See that it is firmly seated in the bottom of the bore hole.

In pressing a primer into place, do not handle it roughly, as it contains the cap and is therefore more sensitive and dangerous than an unprimed cartridge.

When the load is to contain a larger amount of dynamite, press the unprimed cartridges into place in the bottom of the hole first, and place the primer with the cap pointed toward the rest of the charge on top. When the bore hole is dry, and it is desirable to have the charge concentrated in one place, it is a good practice to slit the sides of the cartridges from end to end with a knife so that the dynamite can be compacted into a smaller space. The primer should not be slit. When the bore hole is wet, it is not advisable to slit the cartridges.

In all classes of agricultural blasting the charge should be pressed firmly into the bottom of the bore hole so that no air pockets are left, as they weaken the action of the explosives.

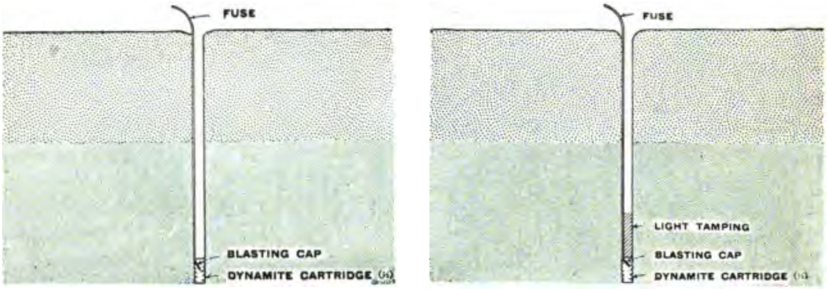
For most work it is necessary to determine the correct amount of explosives by a few test blasts. This is pointed out in the descriptions of the different classes of blasting.

## Tamping

After the charge is in place, the bore hole must be tamped; that is, filled to the top with some material, in order to confine the charge closely and to insure its effectiveness. This tamping should be made as tight as possible, so that the gases will not blow out as through the muzzle of a gun.

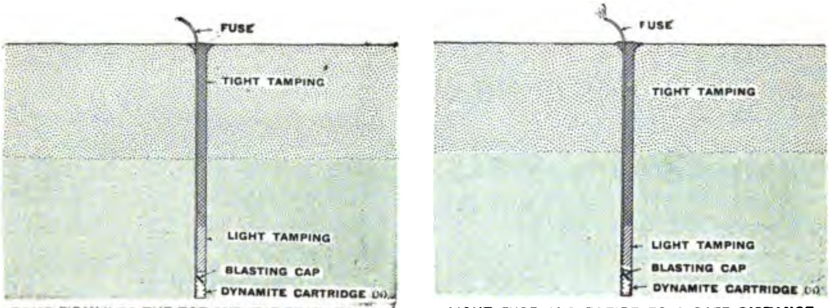
To guard against danger of prematurely detonating the charge, the first 5 to 8 inches of tamping should not be packed with any considerable force, but should be gently pressed. When this amount of lightly tamped material covers the primer, the rest of the tamping should be made as hard as possible so that no open-air spaces are left, and should extend to the mouth of the hole, entirely filling it. The tamping should be done with the wooden tamping stick used in one hand. Care should be taken to prevent stones and pebbles from falling into the hole while loading and tamping.

Moist clay free from gravel and clods makes good tamping material. Free running sand or moist loam is also good. In wet work, when a foot or more of water covers the charge in shallow holes, it will not be necessary to add other tamping, as the water will hold the charge sufficiently tight.



PRESS CARTRIDGE DOWN GENTLY; DON'T POUND

PUT IN 6 TO 10 INCHES OF EARTH AND TAMP LIGHTLY



TAMP FIRMLY TO THE TOP AND IT IS READY TO FIRE

LIGHT FUSE AND RETIRE TO A SAFE DISTANCE

FIG. 12. STEPS IN LOADING AND TAMPING A BORE HOLE.

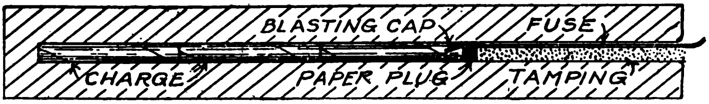


FIG. 13. A PAPER PLUG PLACED OVER THE PRIMER BEFORE TAMPING.

Before beginning tamping it is well to measure the depth from the surface to the top of the charge, so that if the tamping must be removed to get at a misfire there will be no danger of disturbing the primer. It is a good practice, especially where heavy charges are used, to place two inches of paper or dry leaves immediately over the primer, so that they can be used as a safety marker should the tamping need to be removed for any cause.

## Firing

Exploding the charge is called firing. No blast should be fired until persons, animals, and vehicles are well out of range. In selecting a safe place to watch a blast, do not get behind a tree or building, but stand in the open at a safe distance from the blast, so that you can see the flying fragments and dodge any that may come beyond reasonable bounds. Do not have the sun in your eyes, as it may obscure flying missiles.

The firing can be done either by means of blasting caps and fuse or by means of electric blasting caps and a blasting machine.

### Firing with Cap and Fuse

The cap and fuse method of firing may be used for many kinds of agricultural work. In most cases when a single charge is to be fired, this method is entirely satisfactory and somewhat cheaper.

In using cap and fuse, the fuse should be of sufficient length in deep holes to extend out of the bore hole several inches, and in shallow holes long enough to allow the blaster time to reach a safe place. Roughly speaking, fuse burns at the rate of about 2 feet per minute.

### Firing by Electricity

For some kinds of work, electric firing is more effective and economical, and practically essential. In general, this is the only way in which several charges in different holes can be fired simultaneously. It is often of great advantage to fire charges at the same time, as each tends to help the other. Large boulders and stumps with spreading roots can be blown out and broken up more thoroughly and with less dynamite if the explosive is distributed in several holes in different places under the boulder or stump and all of these charges exploded at one time. Groups of stumps standing close together can also be blasted in this way. In order to dig a ditch satisfactorily, it is always necessary to explode a number of charges simultaneously and in dry soils this can be done only by electric blasting. Firing holes simultaneously is of advantage in well-sinking and many other kinds of blasting.

Electric firing is much safer and surer than cap and fuse and is to be recommended for all road work or for other blasting when passing persons might be injured.

The equipment needed for blasting by electricity, in addition to the explosive, consists of

Electric blasting caps
Connecting wire
Leading wire
Blasting machine

When the charges have been primed with electric blasting caps and tamped, the two copper wires protrude from the ground over each charge. These two wires should be separated and one of them connected to one of the wires of the electric blasting cap in the next hole on one side and the other to one of the wires of the electric blasting cap in the hole on the other side. In this way, all of the caps should be connected in a row with one free wire extending from the first charge and another extending from the last charge. These loose wires are connected to the wires leading to the blasting machine. This method of firing is called connecting in series.

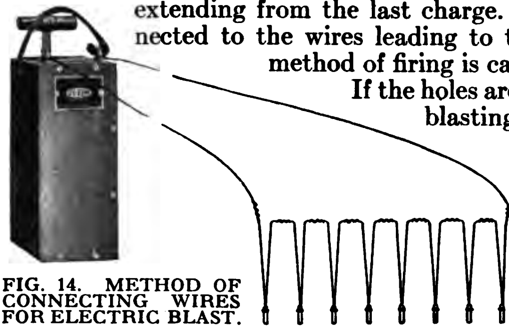


FIG. 14. METHOD OF CONNECTING WIRES FOR ELECTRIC BLAST.

If the holes are too far apart for the electric blasting cap wires to reach between them, the wires are joined by pieces of connecting wire.

Connections are all made by twisting bare wire ends securely together. All wire ends should be scraped with a knife so that they will be free from grease or corrosion when connections are made.

Always be sure that there is a complete circuit of wire offered for the passage of the electric current. Otherwise the blast will not fire, for the current must pass through each electric blasting cap in order to fire it. Should there be any bare joints resting upon damp ground or in water, or should one bare joint touch another, there is a likelihood of a short circuit through which the electric current will pass instead of around the entire blasting circuit. The bare joints or other uncovered places in the wires can be kept away from water or damp ground by holding up the wire with a stick, block of wood, or stone, placed at one side of the joint.

The circuit may be tested to ascertain whether there are any breaks in the connections or wires and the breaks located, by the du Pont galvanometer.

The blasting machine should be placed on firm, level ground. The leading wire should be long enough to enable the one who operates the machine to be outside the danger zone. Never connect the wires to the blasting machine until it is time to fire, and keep careless persons from tampering with the machine or leading wire while the shots are being loaded.

When ready to fire, lift up the rack bar of the blasting machine as far as it will go, and using both hands, with one quick, hard stroke, push it down to the bottom of the box with a solid thud. "Try to knock the bottom out of the machine."

## Handling Misfires

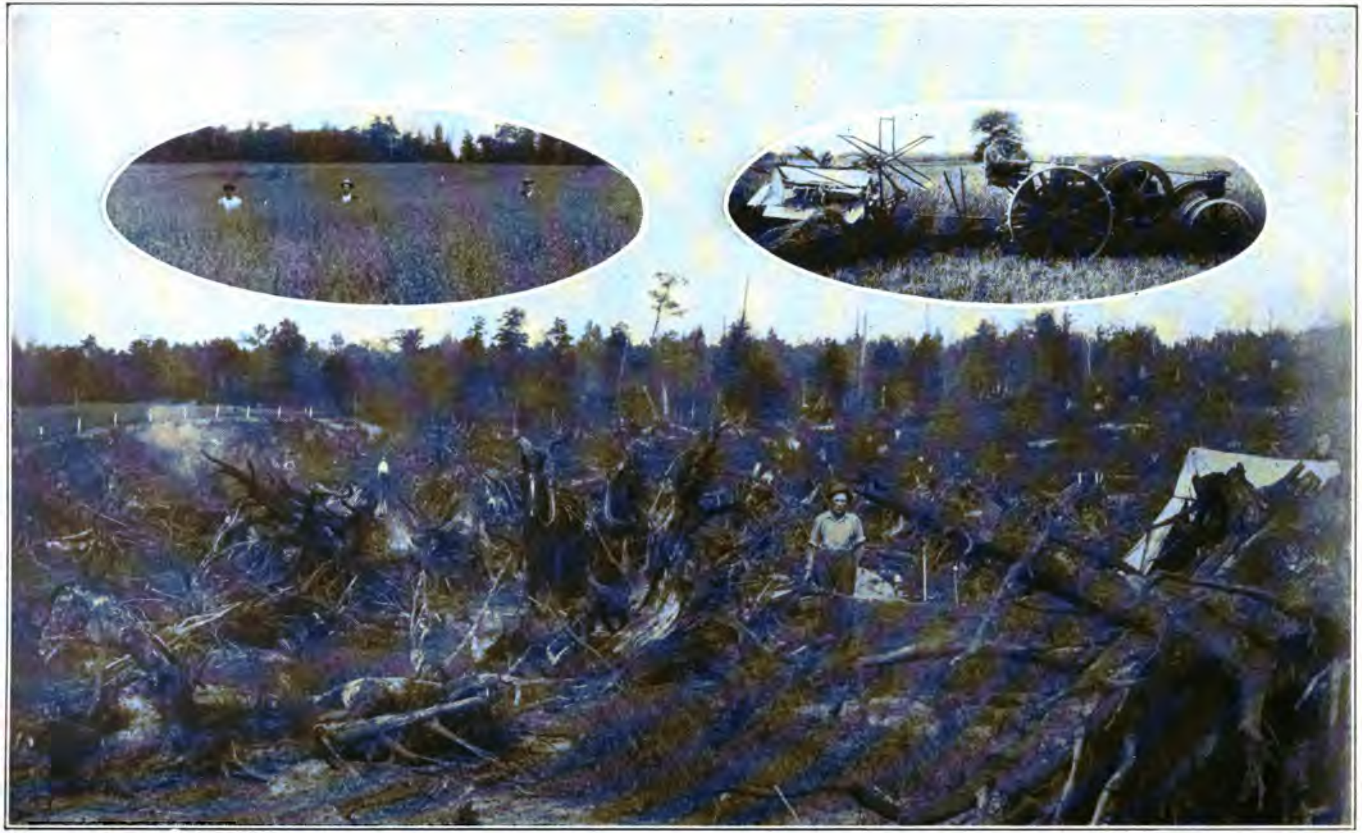
The use of reliable explosives and caps and careful priming and charging greatly reduce the chances of misfires. Electric blasting also results in a decrease of delayed or missed fires.

When a shot does fail to fire, the investigation of the trouble should be placed under the direction of a careful and experienced workman, who should make his examination in a slow, methodical manner before beginning the work of repriming. No other persons should be allowed to remain near him, as their presence or suggestions may cause confusion.

When a misfire occurs with blasting cap and fuse, it is never safe to return immediately to the hole. The fuse may have been injured in tamping, and instead of burning rapidly may delay for a long time, and then re-ignite the powder in the lower end of the fuse and fire the blast. The interval of waiting should be as long as possible, preferably until the next day if the firing is done in the afternoon. In all cases it should be several hours. In order to prevent wasting time waiting for a blast whose fuse is not even lighted, make certain when lighting the fuse that the flame spits out, showing that the powder column is on fire.

When electric blasting caps are used, it is generally safe to go back to investigate the trouble immediately after disconnecting the wires from the blasting machine. The investigation should consist first of a search for broken wires, faulty connections, or short circuits. If such are found, make the proper repairs, reconnect the leading wires, and operate the blasting machine. Many so-called failures are the result of poor connections or of connections being in contact with wet ground or other conductive material.

If the cause of the misfire seems to lie in the hole itself, there are several possible methods of procedure. If the hole is untamped or is tamped with water, make up another primer, place it on top of the charge, and fire. If the ground is soft and wet, drill and load a second hole, which, when fired, will cause the first charge to explode. In doing this great care must be taken. Such a hole must be far enough away from the charge to make drilling and loading safe, but close enough to cause detonation by concussion and to make sure that the first charge will be blown out together with the rock or confining ground. When it is not possible to do this, the tamping can be carefully removed almost down to the charge with a spoon and hardwood probe, a new primer inserted, and the hole retamped. This must be done very cautiously, however, especially when the cap is in the top cartridge of the charge, as the cap may be fired by friction or impact.



STUMP LAND CLEARED AND PRODUCING CROPS HARVESTED WITH MODERN LABOR-SAVING MACHINERY IS MEETING THE DEMAND FOR A LARGER SUPPLY OF FOODSTUFFS.

# LAND CLEARING

A very considerable saving is possible in land clearing, provided the proper methods are employed. The two best methods of clearing are with explosives and with pulling machinery. Each of these has its advantages and is particularly adapted to certain kinds of land or certain conditions. In many cases the greatest economy in clearing is effected by a combination of the two methods, by the use, that is, of both explosives and pullers.

To make possible the successful utilization of land, all fields must be cleared of stumps and boulders.

| **Well Cleared Fields** | **Stumps and Boulders** |
|---|---|
| Have all the land open for the production of crops; | Occupy space and reduce the producing size of fields; |
| Permit using the most effective labor-saving machinery; | Prevent the satisfactory use of modern farm machinery; |
| Are attractive in appearance, increase owner's interest and selling value; | Are unsightly and reduce both the owner's pleasure in the farm and its selling value; |
| Permit the destruction of weeds and crop pests by ordinary tillage operations; | Provide breeding places for weed and crop pests; |
| Allow the adoption of systems of tillage that will prevent erosion. | Increase the danger of erosion by preventing satisfactory plowing. |

# Blasting Stumps

The root systems of the different forest trees vary considerably according to the class of tree, the nature of the soil and its depth to sheet water. Ordinarily, forest trees are divided on the basis of their root systems into three classes: those having tap roots; those having no tap roots, but only lateral fibrous roots; and those having both a small tap root and many lateral roots. When trees that normally develop heavy tap roots are grown on soils where the ground water level is very near the surface, the tap root will be noticeably shortened or entirely wanting. Lateral-rooted trees growing in loose, well-drained soils may send heavy lateral roots to considerable depths.

The blasting of stumps is materially influenced by several factors, chief among which are:

The character of the root, whether tap or lateral.

The state of preservation of the stump, whether sound or partially decayed, freshly cut or green stumps being much harder to blast than those from which the small roots and bark have decayed.

The nature of the soil, whether sand or clay, as this has much to do with the resistance offered to the dynamite.

The moisture content of the soil.

Success in stump blasting is a matter of common sense and discretion, and the work may be undertaken by anyone of reasonable intelligence, who will first try a few experiments on small stumps, and follow out carefully the rules laid down in the following pages for the several kinds of stumps.

## Blasting Tap-Rooted Stumps

There are two distinct methods of blasting tap-rooted stumps. The charge may all be placed in a single hole bored into the root, or it may be placed in one, two, or three holes alongside the tap root. When two or more holes are used, electric firing must be practiced. Each method has its advantages. Placing the charge in the stump requires more labor and a smaller charge, while the other method requires but little labor and a greater amount of explosives. The first method reduces the stump and tap roots to smaller fragments than the second, and is, therefore, generally used by those blasting stumps for distillation. It should not be employed for stumps with decayed or hollow tap roots, as they can be gotten out better by the second method described.

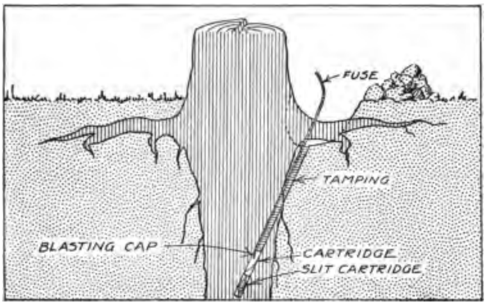


FIG. 15. METHOD OF BORING AND LOADING A TAP-ROOTED STUMP FOR A CAP-AND-FUSE BLAST. THIS LOCATION OF THE BORE HOLE IS BEST WHEN THE BORING IS DONE WITH HAND AUGERS.

**Loading in the Tap Root.**—In order to place the charge in the root a little soil is first removed with a spade, so that the tap root is exposed to a depth of a foot or more. The hole is then bored diagonally downward through the center of the root by means of the heavy 1½-inch or 2-inch wood auger. This hole should reach well below any possible depth of subsequent tillage, and more than half way through the root.

In loading it is best to use a half-cartridge primer made with cap and fuse and to remove the rest of the charge from the paper shell. The charge should be packed firmly in the bottom of the hole and the primer pressed close against it. The hole should then be tamped tight up to the very collar. Better results will be obtained if the loose earth is packed firmly back into the hole made to expose the tap root (Fig. 15).

The charge will vary from a half-cartridge primer alone for small roots to three or four cartridges for very large solid stumps. The explosive recommended is Dumorite or Red Cross Farm Powder.

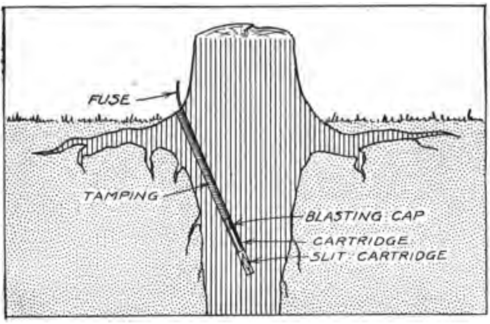


FIG. 16. WHEN POWER BORING MACHINES ARE USED, NO EARTH IS SHOVELED, AND THE HOLE IS STARTED INTO THE WOOD SLIGHTLY ABOVE THE SURFACE OF THE GROUND.

**Boring Holes in Tap-Rooted Stumps with a Power-Driven Auger.**—When there is a large number of stumps to be blasted, a power-driven auger will greatly facilitate the work of clearing.

There are now available two types of boring machines—one equipped with a light-weight, water-cooled, four horse-power gasoline engine, friction clutch and carburetor such as used with automobiles. The transmission consists of hardened steel spiral gears with thrust ball bearings encased and running in grease. The shaft is slotted to permit horizontal adjustment of 30 inches and a vertical adjustment of 36 inches. At the top of the shaft is a hand-wheel controlled by operator standing upon a platform. Augers of a self-feeding design for either earth or wood boring having a diameter of two inches and a twist of 30 or 40 inches are supplied. Both motor drive and power auger are mounted upon a platform attached to a specially constructed steel frame mounted on a running gear with 30-inch rear wheels and 24-inch front wheels. The machine is so constructed and mounted that it is not necessary to change the level of platform to go over obstructions or into ditches. Shafts are attached to running gear for animal traction.

For those who have either a Samson or Fordson tractor, there is a special attachment enabling the power auger to be driven by the tractor's engine. Further information may be obtained by addressing any of the branch offices of the du Pont Company.

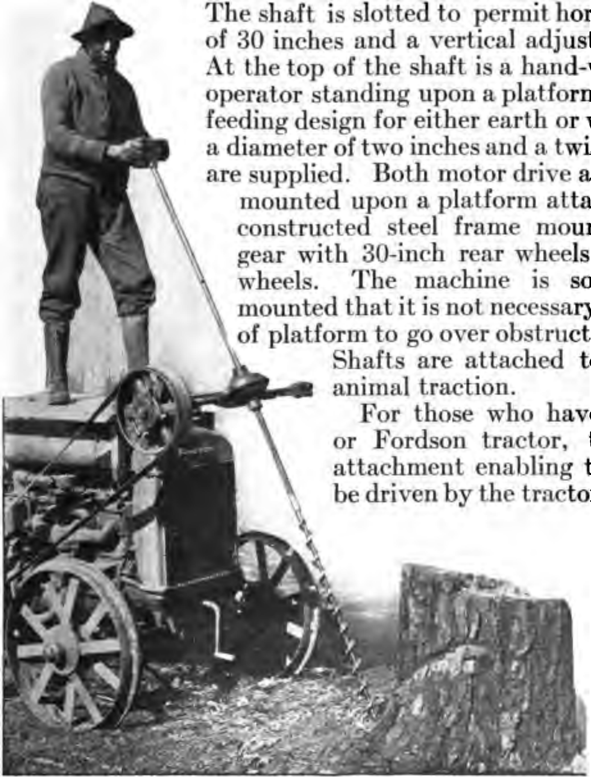


FIG. 17 BORING HOLE IN TAP-ROOTED STUMP WITH COWAN-ALFORD POWER BORING MACHINE.

**Loading around the Tap Root.**—In the second method of blasting tap-rooted stumps, the charges are placed around the root, between it and the soil. Much depends on the depth and location of the bore holes. They should be not less than three feet deep, usually deeper, and placed close against the tap root, so that the charges will lie immediately alongside the wood. The wood auger will not be needed, as the holes can be made faster with a subsoil punch, crowbar, or soil auger.

For blasting small or old stumps only one hole is used and the charge can be fired with cap and fuse. If the hole is dry, all the cartridges except the primer should be slit from end to end and packed tightly in the bottom. The primer should then be pressed in firmly and the hole well tamped. The charge should seldom be less than 1½ cartridges. For clay and clay loam subsoils Red Cross Farm Powder is satisfactory, but in light or sandy subsoils, Red Cross Extra Dynamite, from 40 to 50 per cent., will give better results. Dumorite may be used advantageously in both kinds of soil. In light sandy soils, be it noted, loading in the tap root, as previously described, is usually more satisfactory.

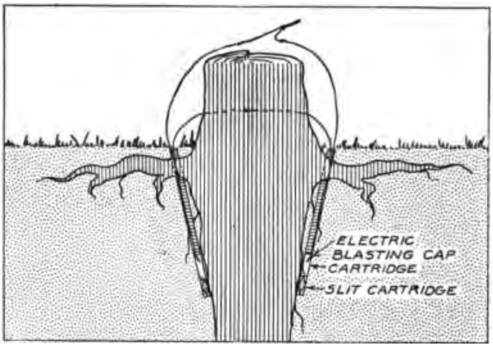


FIG. 18. FOR BLASTING TAP-ROOTED STUMPS WITH DISTRIBUTED CHARGES. TWO OR MORE HOLES ARE PUNCHED ALONGSIDE THE MAIN ROOT AND LOADED. ONLY ELECTRIC FIRING CAN BE USED IN THIS METHOD.

To get out large tap-rooted stumps, which are so firmly brace-rooted that the single-hole method of blasting is ineffective, two or more charges are distributed around the tap root. The holes should be put down with great care and should generally be not less than four feet deep. The charges will vary from 1½ to 2½ cartridges for each hole. For firing these distributed charges electric blasting caps must be used.

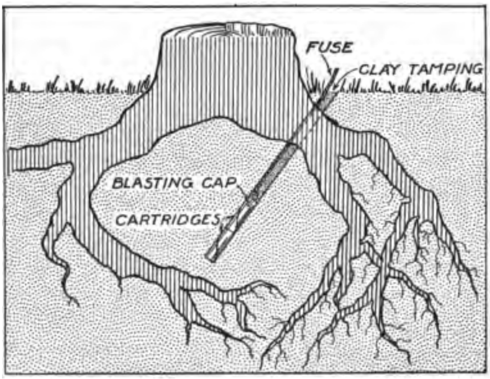


FIG. 19. CORRECT METHOD OF LOADING A SMALL LATERAL-ROOTED STUMP FOR A SINGLE CHARGE BLAST. THE CHARGE MUST BE LOADED WELL UNDER THE BODY OF THE STUMP, AND TAMPED THOROUGHLY.

## Blasting Semi-Tap-Rooted Stumps

When stumps have a tap root of medium size and a heavy set of lateral roots, the loading will be intermediate between the loading for tap-rooted and lateral-rooted stumps. This loading is practically the same as that shown in Fig. 18, the chief difference being that an occasional charge will be needed also under the heavier brace roots. (See Fig. 20.)

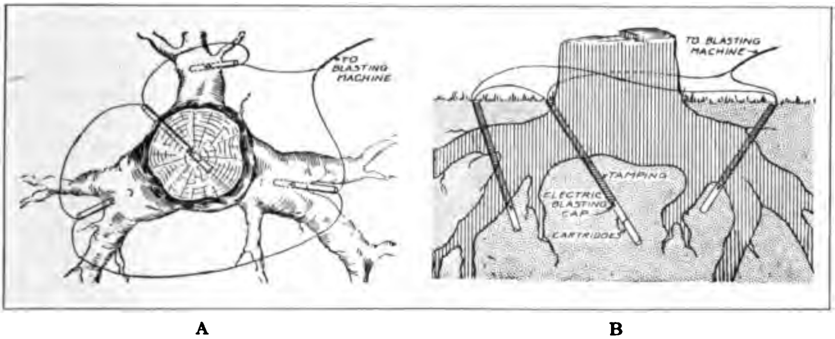


FIG. 20. METHOD OF LOADING LARGE LATERAL STUMPS WITH DISTRIBUTED CHARGES, FOR AN ELECTRICALLY FIRED BLAST. A SHOWS WHERE THE HOLES SHOULD BE STARTED AND, IN A GENERAL WAY, HOW THEY SHOULD POINT, AND HOW THE WIRES ARE CONNECTED IN SERIES TO THE LEADING WIRE. B SHOWS THE LOCATION OF THE HOLES UNDER THE STUMP.

## Blasting Small Lateral-Rooted Stumps

When stumps have no tap root, but only lateral ones, the loading will depend on the nature of the soil and the size and state of preservation of the roots. If the roots are small or are partly decayed the charge may all be placed in a single hole started a little way back from the stump and sloped under the part of the stump that will be hardest to lift.

Here again, the depth of the hole will play an important part. If it is too shallow the blast will only split the stump and fold the parts back without blowing them out. Shallow loading is therefore advisable only when the stump is to be split and then pulled as is described on page 43. For blasting the stump out entire, the loading should seldom be shallower than 30 inches, and, if the stumps are hard to blast, 4 feet is better. The tool for making holes is a crowbar or a subsoil punch (Fig. 3). A soil auger (Fig. 6) is frequently needed for deepening the holes for blasting large stumps.

The size of the charge will run all the way from less than a cartridge to several cartridges. For such a single hole blast, cap and fuse would be used.

Where the subsoil is tight and offers good resistance Red Cross Farm Powder will prove satisfactory. In loose sandy soils 40 or 50 per cent. Red Cross Extra Dynamite will be better than the Farm Powder. Dumorite will be found efficient and economical in both kinds of soil.

## Blasting Large Lateral-Rooted Stumps

The use of distributed charges and electric blasting is essential to the best success in blasting large stumps or those having wide-spreading roots. If the charge is confined in a single bore hole, as in Fig. 19, the effect will be to split and not lift the stump, but if the same charge or even a smaller charge is distributed in several well-located holes, the blast fired by electricity will lift the stump perfectly. The number and location of the holes must be governed absolutely by the individual stump. For stumps slightly larger than can be lifted by a single charge, two holes will usually be sufficient. These should be on opposite sides of the stump, and should point under the stump. For larger stumps three or more holes should be used. One of these should be under the center of the stump and the rest so placed around the outer edge as to form a circle under and around the holding roots, as is shown in the two cuts (Figs 20 and 21).

Care should be exercised to place the center or main charge well under the stump. This is needed for lifting and splitting the heavy part. The other charges should be distributed under the large roots, and may be some distance away from the stump. For this kind of blasting only electric firing can be used.

As in all stump blasting, the holes should be well down in the subsoil—not close up to or in contact with the wood. The best tools for making the holes are the crowbar and the subsoil punch. Soil augers are sometimes used. A good explosive for this work is Red Cross Farm Powder, unless the subsoil is loose and open; then Red Cross Extra 40 per cent. will be found more satisfactory. Dumorite is excellent for this work in either case.

Each separate charge, or hole, is primed with an electric blasting cap. The wires to these caps are connected with each other, as is shown in Fig. 21, and to the leading wire, which is in turn connected to the blasting machine. Several stumps can be wired into the same blast and fired together, but must be connected in series.

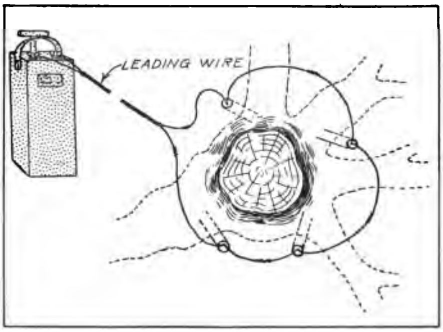


FIG. 21 SHOWING FULL DETAILS OF LOADING DISTRIBUTED CHARGES UNDER AND AROUND A LARGE STUMP FOR AN ELECTRICALLY FIRED BLAST. THE LEADING WIRE SHOULD NOT BE LESS THAN 250 FEET LONG.

Many stumps are found to be only shells, the heart having been entirely rotted away. To blast these successfully, drive a bar down through the hollow into the soil and tamp the stump full of moist soil; then remove the bar, load the hole, and tamp solid. Additional charges should be placed under the spreading roots and all the holes connected and fired electrically.

For cypress, willow or other stumps in very soft, swampy soil, modification must be made in the usual methods of loading on account of the poor resistance offered by the soil and the enormous number of spreading roots. The holes must be so distributed that not only the stump, but all of the main-spreading roots will be blown out down below plowing depth. The quicker-acting Red Cross Extra Dynamite of 40 or 50 per cent. or Dumorite gives best results. To insure the most efficient action of the explosives the shots should be fired as soon as possible.

In the states of Washington and Oregon and in parts of California, where the rainfall is heavy and the ground in the forests is always damp, many of the trees grow to great size—some being eight or ten feet in diameter. The roots of these trees usually spread out near the surface and do not grow deep into the ground as might be expected, tap roots being extremely rare.

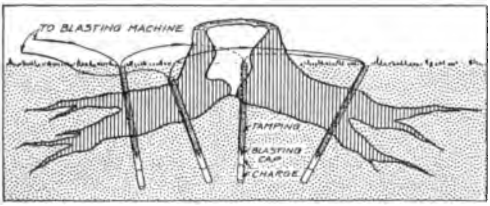


FIG. 22. METHOD OF LOADING A LARGE HOLLOW STUMP WITH DISTRIBUTED CHARGES FOR AN ELECTRICALLY FIRED BLAST. THE ONLY VARIATION FROM THE ORDINARY LOADING OF LARGE STUMPS (FIGS. 20 AND 21) IS IN DRIVING ONE HOLE DIRECTLY THROUGH THE HOLLOW.

The principal object when blasting these stumps is to get out as much of the stump and its roots as possible at a minimum cost.

If the charge of explosives is so gauged and located as to split the stump it generally fails to bring out all the pieces. It is therefore better to blast the stump out first and then split it afterwards as can easily be done by exploding a small quantity of dynamite in auger holes.

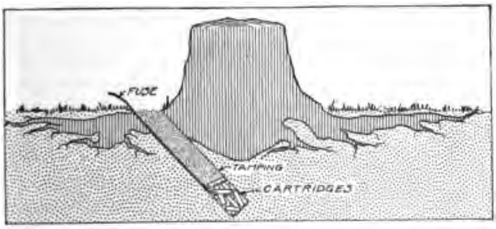


FIG. 23. SHOWING LOCATION OF A SINGLE LARGE BORE HOLE AND METHOD OF LOADING LARGE WESTERN STUMPS, USING BLASTING CAP AND FUSE.

When the subsoil is clay the common rule for estimating the quantity of du Pont or Repauno Stumping Powder needed for blasting fir, pine and cedar stumps of any size up to four feet in diameter is to use one and one-half pounds of powder per foot of diameter. For larger sizes, from two and one-half to three pounds for each foot in diameter should be used. Stumps in gravelly or loose ground require one pound more for each foot in diameter. To estimate the quantity of these explosives necessary to blast out redwood and other big tree stumps larger than eight feet in diameter, square the largest diameter, measured in feet, and use the product as the approximate number of pounds required. For example, if a stump is eight feet in diameter the charge of du Pont or Repauno Stumping Powder should be about the square of eight, or sixty-four pounds. Stumps less than eight feet in diameter require a little greater charge in proportion to their size than do the larger stumps, and the rule with them is to use as many pounds of du Pont or Repauno Stumping Powder as eight times the largest diameter in feet. On this basis a stump six feet in diameter would need about forty-eight pounds of powder.

In case Dumorite is to be used—and it is both highly efficient and economical for blasting the large stumps of the Pacific Northwest—the charge should consist of the same number of cartridges as contained in the recommended charges of Repauno or du Pont Stumping Powders—this number being easy to calculate on the basis of the number of cartridges that the several powders run to the fifty-pound case.

However, the successful blasting of these large stumps depends greatly on the judgment of the blaster, and these rules for calculating the proper charge can be considered only as a general guide. This can easily be understood when it is remembered that, owing to difference in soil or some peculiarity in the growth of the tree, it sometimes requires the same quantity of explosives to bring out a stump six feet in diameter properly as it does another one eight feet in diameter.

The charge of explosives is best placed so that there will be from sixteen to twenty-four inches of earth between it and the bottom of the stump. The force of the explosion will then radiate to all sides, lifting the stump clear of the ground, and bringing with it the greatest length of roots. If the charge is placed too close to the stump, the effect is to split it, leaving the roots to be dug out at extra labor and expense. As the large amounts of powder required to blast out a stump of this character cannot be contained in a bore hole such as is advised for small stumps, a larger bore hole is required. The earth is loosened by means of a crowbar or long chisel and cleaned out of the hole with a long handled tilling spade. The charge is loaded in this large bore hole in exactly the same manner as in other holes.

In blasting very large stumps a trench is dug large enough to permit placing the entire charge of explosives directly underneath the center of the stump. A little powder blasted in holes punched with a crowbar will prove of great assistance in digging this trench, especially when the subsoil is clayey. It is important that the charge be firmly tamped. The blaster should avoid being on the same side of the stump as the trench when the blast is fired, as fragments or stones may be thrown with more violence and to greater distances on that side.

Where there is much heavy stumping and means are available for purchasing the needed equipment, the combination methods described on pages 42 to 45 are recommended for West coast conditions. See also pages 46 to 49 for methods of piling and disposing of stump fragments.

"The Farmers' Hand Book of Explosives" is prepared especially for the states lying east of the Rocky Mountains and the explosives recommended are especially suited for this region. Readers interested in developing land in Washington, Oregon, or California should write for a copy of "Clearing Logged-off Lands," giving specific data applicable to that section.

A TYPICAL PIECE OF WASTE LAND.

## Table of Approximate Charges for Blasting Stumps

No absolute rule can be laid down giving the required charge for blasting stumps of different sizes, but the following table, which is based on the blasting of old but solid stumps in firm, dense soil, can be used as a guide.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diameter of stumps in inches | 12 | 18 | 24 | 30 | 36 | 42 | 48 |
| Number of cartridges of Red Cross Farm Powder | 3 | 4 | 6 | 7 | 8 | 12 | 15 |

If the stumps are green, or if the soil is loose or sandy, these amounts must be increased, whereas if the stumps are partly decayed, lighter loading will do the required work. If Dumorite is used, these charges can usually be somewhat reduced.

These estimates are made for cases where the stump is to be blasted out entirely and the work is to be done by the dynamite alone. If the object is merely to break or loosen the stump before or after pulling it with a stump puller, then, of course, the charges can be reduced to one-third or one-half the quantities named.

By starting with the charges given in this table and making a few experimental shots, increasing or decreasing the charge in accordance with the results obtained, each operator can easily determine for himself the proper charges. The aim should be, obviously, to do the work with the least possible amount of powder.

## Stumping by a Combination of Methods

All men have their individual tastes and preferences. Some swear by explosives for getting out stumps and others by stump pullers. A third class take the middle ground and use the two in conjunction with each other. Wide experience seems to show that when stumps are scattered, as in old cultivated fields; or where there is but a small amount of stumping to do in any one place, as in clearing up small woodlots or corners; or when stumps are to be cleared out of an orchard; or when the stump wood is being obtained for the turpentine industry, explosives alone do the most satisfactory work.

There are various stump pullers on the market operated by hand power, horse power, gasoline, and steam. When large numbers of small stumps are to be removed from sandy soil and horse or other power is available, the puller, used alone or with a minimum of dynamite, is more effective and more economical than blasting.

In general clearing operations, however, where the stumps are either large or green, the most careful work must be done to get the desired results with either individual method. The balls of earth on the roots lifted by the pullers and the occasional failures of the dynamite to raise the stump entirely out of the ground are both objectionable. If the tract to be cleared is large enough to warrant the investment in a stump puller, explosives and such a machine can be used very satisfactorily together. Dynamite is used for splitting the stump and freeing the roots of dirt either before or after pulling and the puller is

A VALUABLE CROP REPLACING STUMP-COVERED ACRES IS THE RESULT OF USING EXPLOSIVES FOR LAND-CLEARING.

employed to draw out the stump or the roots, the object being to remove all stump fragments and leave the land clear for tillage. The stumps are well shattered and therefore easier to pull out and to handle after they are out. The strain on machinery, horses, and harness is lessened, the disagreeable and time-consuming work of cleaning dirt off the roots is eliminated. As the holes left are small, relatively little filling in is necessary in preparing the ground for cultivation. The combination method of stumping thus has the great advantage of saving explosives, time, and labor. A large number of tests, chief among which are those conducted by the University of Wisconsin, have proved that on large areas it is better than either pulling or blasting alone.

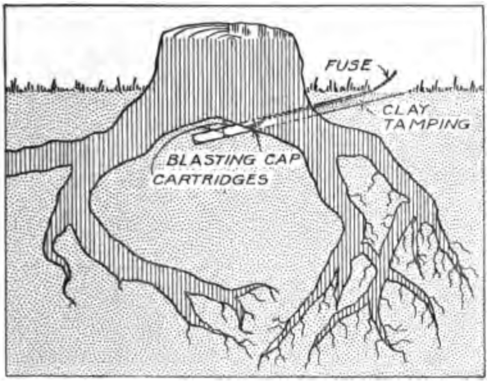


FIG. 24. LOCATION OF A SHALLOW BLAST FOR SPLITTING A STUMP FOR PULLING. THE CHARGE SHOULD BE PLACED CLOSE UP TO THE WOOD AND SHOULD BE JUST HEAVY ENOUGH TO SPLIT THE STUMP.

## Blasting before Pulling

Where the stumps of either the white pine, the yellow pine or the various hardwoods are old and breaking down rapidly, the use of the puller is not advisable and dynamite alone can solve the problem. In blasting the tap-rooted light-wood stump after pulling, it is advisable to saw off the tap root before blasting, as then a small charge will shatter the solid portion of the stump satisfactorily.

Perhaps the most satisfactory general application of the combination method is to blast the stumps and then pull the fragments. The loading is done as illustrated in Fig. 24. The object is to split the main part of the stump and loosen the brace roots from the ground so that a minimum of earth will be pulled out. The loading should therefore

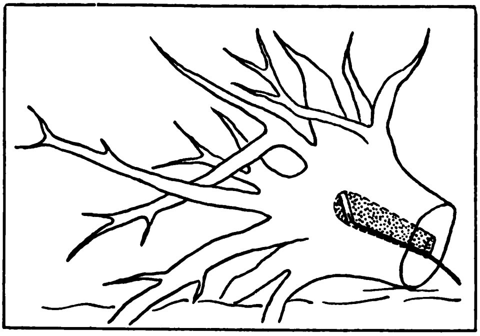


FIG. 25. SHOWING LOCATION OF A CHARGE OF EXPLOSIVES IN A HOLLOW PULLED STUMP.

be shallow so that the hardest blow of the blast will be dealt directly against the forks where the roots branch out from the stump. The charge should be just sufficient to split and loosen the stump. It is usually fired with a blasting cap and fuse.

Red Cross Farm Powder is recommended for heavy soils and Red Cross Extra Dynamite 40 per cent. for light ones, while Dumorite may be used successfully in either case.

This method is highly satisfactory for green stumps or those having heavy spreading roots especially on silty loam, and heavier soils.

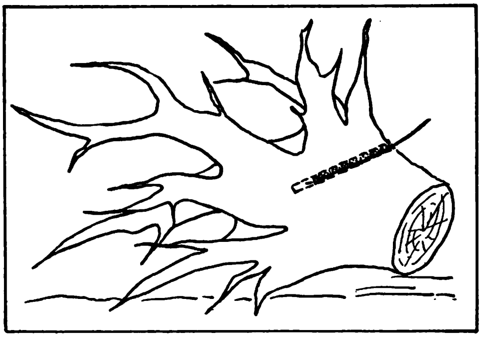


FIG. 26. LOCATION OF A HOLE BORED INTO A PULLED STUMP FOR SPLITTING.

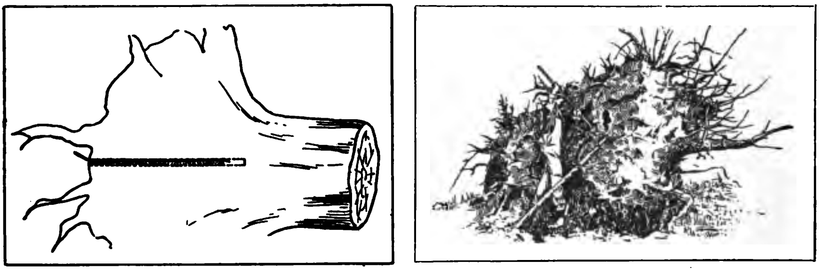
## Blasting after Pulling

In this application of the combination method the stumps are first pulled and then they are blasted to free the roots of dirt and to split the stumps so that they can be piled and burned or used for other purposes. This procedure is not so well suited to extremely large stumps or those having heavy spreading roots as is blasting before pulling. It finds its chief use when the stumps have large single roots or are on sandy land.

There are three methods of blasting pulled stumps:

(a) Any cavity or hollow in the stump may be loaded (Fig. 25). The hole should be well tamped.

This method finds ready use when old hardwood stumps are being pulled. The charge should be kept down to a small amount of Red Cross Farm Powder or Dumorite.



A B

FIG. 27. PUNCHING A HOLE FOR A SPLITTING CHARGE THROUGH THE EARTH CLINGING TO THE ROOTS OF A STUMP. A, LOCATION OF BORE HOLE; B, LOADING THE CHARGE.

BLASTED STUMP FRAGMENTS READY FOR PILING.

(b) A hole may be bored into the thick part of the stump near the original ground line (Fig. 26). Some blasters prefer to bore such a hole in the same direction as the natural hollow.

(c) A hole may be punched through the mass of earth, on the bottom of the stump, to the forks of the main roots (Fig. 27).

Red Cross Farm Powder or Dumorite is recommended for all three methods.

## Felling Trees

The loading for this purpose is the same as for stumping, with the important difference that heavier charges are required, because of the greater weight to be lifted. If this work can be done during a high wind, the wind load on the tops of the trees will assist materially in bringing them down. When a tree is valuable for saw stock it should not be blasted down, as the blast may split the trunk in such a way as to ruin it for the sawmill.

## Disposal of Stump Fragments

While blasting blows stumps out and splits them into fragments that can be more easily handled, it does not of itself clear the land, for the stumps are frequently more in the way when lying on the ground than they were when in the ground. If the stump wood is of value for fuel, or for distillation, it should be saved and hauled to market as soon as possible.

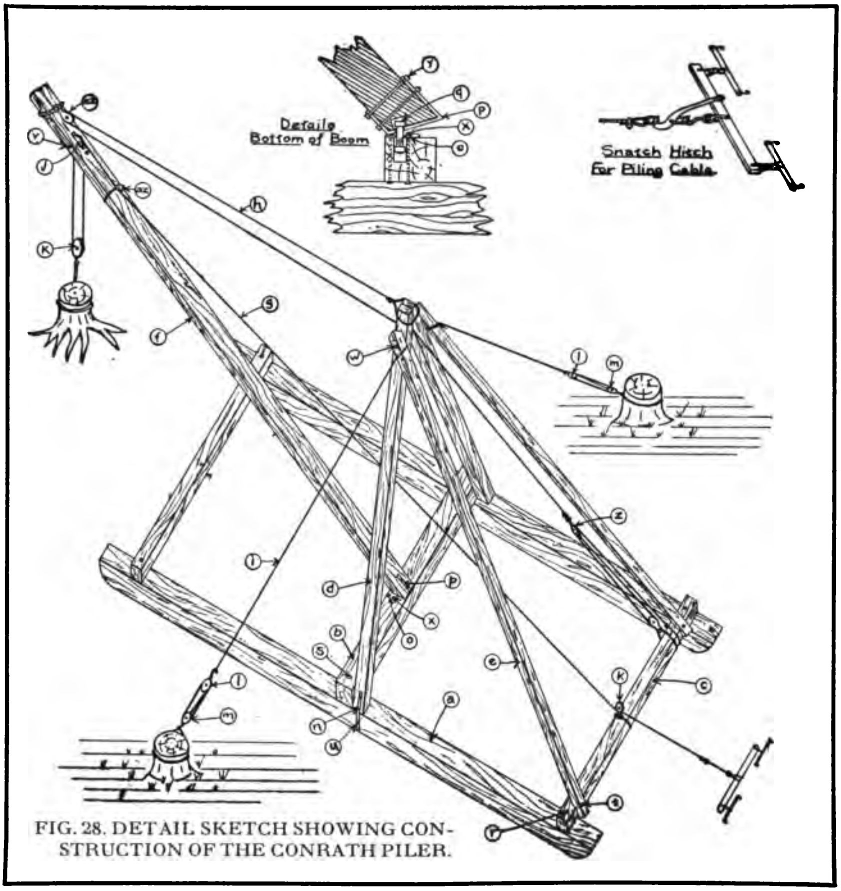


FIG. 28. DETAIL SKETCH SHOWING CONSTRUCTION OF THE CONRATH PILER.

## LIST OF MATERIAL FOR CONRATH PILER

(*a*) 2 skids, 8 x 8 ft. long.
(*b*) 1 cross beam to support the boom, 7 x 8, 9 ft. long.
(*c*) 2 cross beams for ends of skids, 5x5, 9 ft.
(*d*) 2 standards for A frame, 5 x 5, 14 ft.
(*e*) 2 brace poles for A frame, 4 x 4, 18 ft.
(*f*) 1 pole for swinging boom, 7 x 7, 22 ft.
(*g*) 110 ft. ⅜-in. steel cable.
(*h*) 40 ft. ½-in. steel cable for holding boom.
(*i*) 2 25-ft. pieces ½-in. guy cable.
(*j*) 1 shive fastened in end of boom, ¾ x 6.
(*k*) 2 steel blocks for piling cable.
(*l*) 2 double wooden pulleys for ⅝-in. rope.
(*m*) 2 single wooden pulleys for ⅝-in. rope.
(*n*) 2 strips of iron, ½ x 1½, 18 in. long, to fasten A frame to skids.
(*o*) 1 plate of iron, ¼ x 4 in., 12 in. (plate on cross piece at bottom of boom).
(*p*) 1 piece of iron, ½ x 2½, 24 in. long, to fasten bottom of boom to cross beam.
(*q*) 1 bolt for bottom of boom to swing on 1 in. x 4 in.
(*r*) 4 bolts ⅝ x 12 in. long.
(*s*) 2 bolts ⅝ x 14 in. long.
(*t*) 2 bolts ⅝ x 8 in. long.
(*u*) 4 bolts ⅝ x 8 in. long.
(*v*) 1 bolt 1 x 9 in. long.
(*w*) 1 bolt ¾ x 20 in. long, threaded on both ends.
(*x*) 4 bolts ½ x 8 in. long.
(*y*) 2 bolts ⅝ x 9 in. long.
(*z*) 2 single blocks for ⅝-in. rope, for changing elevation of boom.
(*az*) 2 single blocks for ½-in. cable for boom.

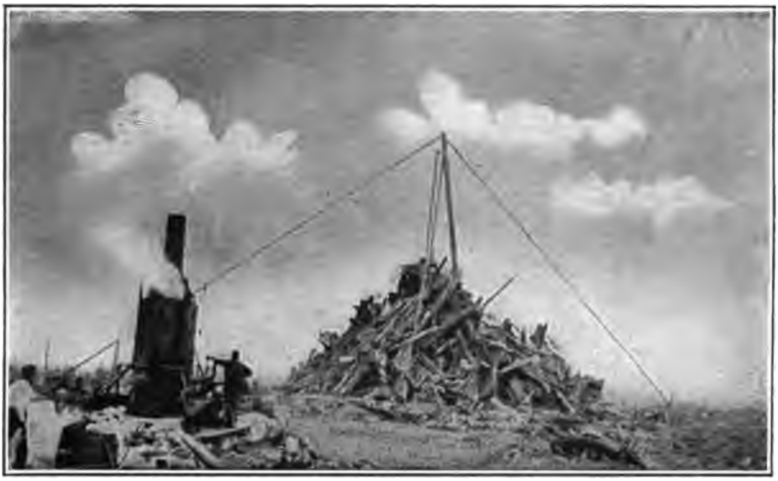


FIG. 29. SHOWING PILING STUMP FRAGMENTS BY MEANS OF A GIN POLE FOR LIGHT WORK A HEAVY TEAM CAN REPLACE THE DONKEY ENGINE.

## Burning Stumps

In many localities stump wood is simply waste, as there is no market for it either for fuel or for distillation. In such cases the easiest and quickest method of burning is to be desired. There are many methods of piling for burning, each method having its advantages under particular circumstances.

**Building Small Piles.**—On small stumping jobs, especially where there is a considerable amount of trash to be burned, the building of small piles, including only two or three stumps, is found very satisfactory. The largest stump fragments can be used for the base of the pile and the smaller fragments piled on top by hand, or by means of teams or pullers.

**Building Large Piles.**—Frequently, especially on extensive clearing operations, it is better to build large piles. When it is necessary to leave the stumps for some time to allow them to dry out, this is an excellent method and some claim that the stumps always burn much better when piled in this way.

For building these large piles the "mast," or "gin pole," is largely used in the West, either in connection with the donkey engine or with heavy teams. The pole may be erected and secured by means of guy wires or ropes, or a standing tree can be used to good advantage. A rope is run through a pulley at the top of the pole and one end is attached to the drum of the engine. The other end is tied around a stump in the field and as the drum winds up the rope the stump is dragged to the pole. The pole is finally burned with the pile. A good idea of this method can be obtained from Fig. 29.

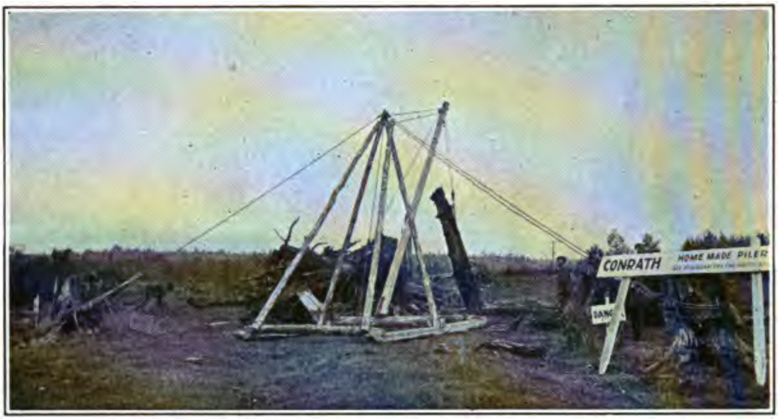


FIG. 30. SHOWING OPERATION OF THE CONRATH PILER.

There are a number of patented as well as home-made "boom pilers" that prove very satisfactory. Some of these are quite heavy and hard to move, while others are lighter and can be easily pulled about the field. One of the simplest of these is the "Conrath Piler," which is shown in detail in the accompanying cuts. It is not patented and can be built on the farm. The timbers may be of sawed lumber, but round poles, cut in the woods, are more generally used, as they are cheaper and just as good. The Conrath Piler can be used both for piling up stumps and for loading wood or stump fragments on a wagon.

The use of a piler on large operations is almost imperative in order to clean up the scattered fragments and débris, so that a free space can be had in which to work, especially when teams and pullers are used. It also allows the free cleared ground between the piles to be plowed and worked while waiting for the piles to dry out sufficiently to be burned.

## Marketing Stumps for Distillation

In the southern states the stump wood is readily salable, for in seven of them the manufacture of turpentine and rosin is a very important industry.

When the supply of gum became exhausted, methods were introduced for extracting both turpentine and rosin from the wood. Although it has been a well-known fact that the stump contains a larger amount of turpentine, rosin, tar, wood oil, and creosote than is contained in the trunk and branches of the tree, formerly only the trunk and branches were utilized by many manufacturers because of the excessive cost of getting the stumps out of the ground and breaking them into fragments suitable for retorts and "hogs." The use of improved hand augers and power boring machines and of Red Cross Farm Powder and Dumorite have overcome these difficulties and thousands of cords of wood are now being blasted for the distilling plants.

Some of the stumps are blasted from land controlled by the distilling companies, some are blasted under contract, and some by individual landowners who are making the funds derived from the sale of the fat wood pay the entire clearing cost and are thus getting their fields cleared at no actual outlay. Indeed the stump turpentine industry offers an excellent opportunity for profit to all owners of long leaf pine stump lands.

For short hauls to market stone boats or sleds can frequently be used and are easy to load and unload. For longer hauls, wagons are better. These can be loaded with the pilers shown in Figs. 29 and 30.

A FEW STICKS OF DYNAMITE WOULD REMOVE THIS BOULDER—NOW A HOME FOR CROP PESTS, A PLACE FOR THRIVING WEEDS AND A SPACE WHERE NOTHING OF VALUE GROWS.

BLASTING A GROUP OF BOULDERS AT ONE OPERATION BY USING THE ELECTRIC FIRING METHOD.

# BOULDER BLASTING

Field boulders, whether loose rocks or solid ledges, present the same obstacles to cultivation as do stumps and therefore their removal is just as necessary as is the removal of stumps. By a judicious use of explosives all classes of boulders and ledges can be successfully removed.

## Methods of Blasting Boulders

There are four distinct methods of loading for breaking field boulders: blockholing, snakeholing, mudcapping, and seam blasting. Blockholing requires the smallest amount of explosives, but the most labor, while mudcapping requires the smallest amount of labor, but a considerably larger amount of explosives; snakeholing is intermediate in both labor and amount of explosives required. Each method has its special use as is pointed out in the following paragraphs.

### Blockholing

Blockholing consists of drilling a hole into the boulder and charging it with a small amount of dynamite. It is the best method for breaking very hard or very large boulders, especially those of the "nigger-head" type that are so difficult to break by other methods. It is also very effective in blasting out-cropping ledges that are too large to remove entirely. The hole should usually be drilled about half way through the boulder and may be an inch or larger in diameter.

When the drill hole is smaller than the diameter of the dynamite cartridge the explosive should be removed from the shell and packed firmly into the bottom of the hole. When the entire charge is in, make a hole for the cap in the top of the powder with a pointed hardwood stick. Press the cap into this hole and tamp the bore hole full and tight with moist soil.

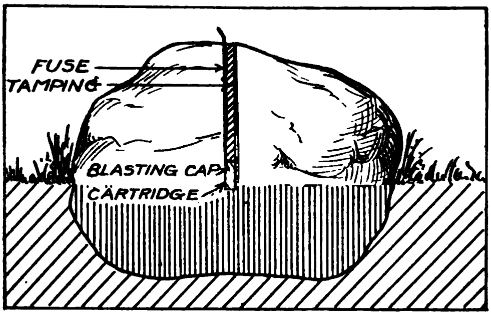


FIG. 32. PROPERLY PLACED BLOCKHOLE. NOTE LOCATION OF EXPLOSIVE AND BLASTING CAP. TIGHT TAMPING IS ESSENTIAL.

When the drill hole is large enough to receive the cartridges, they should be left in the paper shell and a primer used for firing. For very large holes the cartridge shell should be slit several times from end to end. As the confinement is perfect in such loading, any of the du Pont high explosives recommended in this book will give good results. Red Cross Farm Powder, Dumorite and the stumping powders are especially recommended. See pages 22 to 26 for methods of making primers, and pages 27 to 30 for methods of loading and firing.

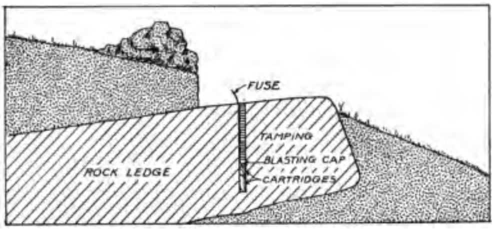


FIG. 33. CORRECT METHOD OF LOADING TO BLAST AN OUT-CROPPING LEDGE. IT IS USUALLY BEST TO REMOVE THE BURDEN OF EARTH. FOR LONG LEDGES, ELECTRIC FIRING IS BEST.

## Snakeholing

Snakeholing consists of punching a hole under, but immediately against, the bottom of a boulder and placing the charge of explosives in as compact shape as the size of the hole will permit. A better idea of the method can be had by glancing at Fig. 34. The explosive being confined on the under side by the earth, can exert a powerful blow on the boulder and will roll it out, or if a sufficient charge is used, will break it into fragments.

This is one of the easiest and most successful methods of boulder blasting. The best explosives for this work are Red Cross Extra 40 per cent. Dynamite and Dumorite. Electric blasting is not generally used unless boulders are very large and more than one charge is needed to blow them out. Many blasters prefer to lift boulders out with a snakehole shot and later break them with a mudcap.

Sometimes in the case of large boulders a mudcap is used on the top of a boulder in connection with a snakehole blast under it and both charges are fired electrically.

See pages 22 to 26 for methods of making primers, and pages 27 to 30 for methods of loading and tamping.

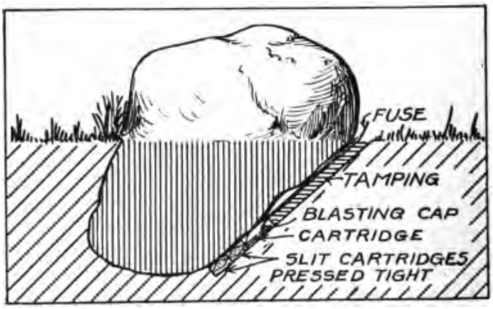


FIG. 34. CORRECTLY PLACED CHARGE FOR A SNAKEHOLE BLAST. THE CHARGE SHOULD BE IN CONTACT WITH THE BOTTOM OF THE BOULDER.

## Mudcapping

Mudcapping is known by a variety of fantastic and expressive names, such as "bulldozing," "blistering," "poulticing," and "adobe shooting," and is made possible by the fast, shattering action of the stronger and quicker acting dynamite. In practice it consists of removing the dynamite from the shell and packing it in a compact conical heap on the boulder, and, after inserting a cap and fuse, covering it with the paper shell and several inches of thick, heavy mud. Frequently the cartridges are simply slit and pressed closely together in a pile, the cap being inserted in the end of one of the cartridges, and the cartridges held in place by the heavy covering of mud.

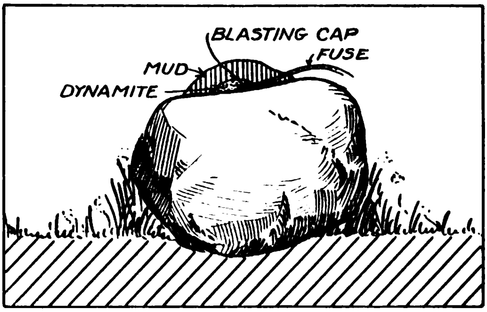


FIG. 35. A WELL-LOCATED MUDCAP. THE COVERING OF MUD SHOULD BE AT LEAST 6 INCHES DEEP AND FREE FROM STONES.

The explosive should be placed on the boulder at the place where it would be struck with a hammer were it small enough to be broken in that

LARGE BOULDERS BROKEN FOR LOADING.

way (Fig. 35). This may be on the top or side. If the boulder is embedded in the ground, a snakehole shot to roll it out on the surface should first be made, because the confining dirt makes it much harder to break with a mudcap shot. The mud covering should be as thick and heavy as it is convenient to make it, not less than 5 or 6 inches, and should be free from stones, as the blast will throw them as though they were bullets. For the same reason a stone should never be laid on top of the mud.

The explosives used are Dumorite or Red Cross Extra or Straight Dynamite 40 per cent. for hard "nigger-head" boulders.

## Seam Blasting

Frequently ledges and boulders have seams from which the mud or stone chips can be removed to a considerable depth. When such a seam is as much as one-half inch wide, successful blasts can be made by packing a reasonable amount of 40 per cent. or stronger dynamite into the crack and tamping it securely with moist clay. This method will require about the same amount of dynamite as snakeholing, but is more satisfactory for badly seamed boulders or ledges. The greatest care must be exercised in placing and tamping the charge to prevent the expanding gases from escaping through the cracks.

## Table of Charges for Blasting Boulders

On account of the differences in hardness of rock in different places, and the variations in the shape of boulders in a single field, it is impossible to give exact information as to the quantity of explosive to use, but the following table, which is based on stone of average hardness loaded with du Pont Straight 50 per cent. Dynamite, will give some idea of the charges to use in making test shots. The recommendations are valuable only for making the first trial shots. After these are made, the blaster should be governed by the results obtained.

| Diameter of boulder in feet | Number of cartridges required—Du Pont Straight, 50 per cent. | | |
|---|---|---|---|
| | Mudcapping | Snakeholing | Blockholing |
| 1½ | 2 | 1 | ¼ |
| 2 | 3 | 1 | ¼ |
| 3 | 4 | 1½ | ½ |
| 4 | Don't attempt | 4 | ¾ |
| 5 | Don't attempt | 6 | 1 |

This is based on the use of du Pont Straight Dynamite of 50 per cent. strength. If Red Cross Extra 40 per cent. Dynamite or Dumorite is used, increase the amounts by about one-third, and if Red Cross Farm Powder is used for snakeholing or blockholing, double the amounts.

## Disposal of Boulder Fragments

The fragments of stone can be advantageously used for building foundations, walls, fences, and roads, for making concrete, for filling gullies or discarded ditches and for forming blind drains to remove excesses of rainwater.

When large boulders leave deep holes much of the débris can be buried in the bottom of the holes, but care must be taken to keep it well below plow depth.

# Vertical Farming

The farmer of today is beginning to realize that deep cultivation of the soil will double his productive acreage, double his crop production. The growth of plants is largely dependent upon the nature of the subsoil around their roots and at a considerable depth below. There are tons of plant food in the deep subsoil, but plants usually derive no benefit from this supply because the earth is so tightly packed that their roots cannot penetrate deeply. A tight, impervious soil also prevents the entrance of water and air, both of which are essential to the feeding of plants. Such a subsoil must be opened up, made porous and crumbly in structure, in order to allow free circulation of water and air and unhampered root development. No machinery is able to reach deep enough to do this; the subsoil can be cultivated only by the use of explosives. When shattered by blasting, it is instantly converted into a cracked, well pulverized earth which is in a condition to absorb the maximum amount of water and produce the heaviest crops.

Crop production in the United States is limited above all else by lack of moisture during the growing season. Yet there is a sufficient rainfall in most of the agricultural sections to supply moisture for more than double the average yields. The greater part of this rainfall is lost, so that the plants receive no benefit from it. The surface soil can absorb but a small quantity of the water and the hardpan in the subsoil prevents further absorption. Were the soil shattered so that it could take in the water and let the surplus drain downward to be stored in the depths of the soil for future use, the interior of the earth would form a reservoir of moisture and nourishment to supply the plants during the summer. As it is, however, the top soil is likely to become too much saturated for good cultivation, and the remainder of the water runs off, sometimes doing damage, moreover, as it goes, by dragging the fertile top soil with it, leaving nothing but the hardpan that was below, or by digging gullies or making wet spots in the land.

Air in the subsoil is an essential to plant growth as air above the soil. It furnishes nitrogen and oxygen, essential elements of plant food. It supports bacteria which are beneficial to the plant and checks the growth of harmful bacteria. A well-aerated soil remains warm in temperature, and makes possible the most favorable conditions for plant development.

A plant receives its nourishment through its roots. If their growth is hindered by hard, compact earth, or hardpan, the actual area through which it may imbibe nourishment is limited, and its energy is used up in struggling below, instead of in fruition above, the surface. On the other hand, if the roots are able to reach down into the soil, they draw up nourishment by capillary attraction, and thus the tons of plant foods in the depths of the soil become available.

A well-cultivated, well-aerated, and well-drained soil such as is formed by subsoil blasting cannot help but result in beneficial effects upon the crops. However, these effects are naturally more obvious the second and third years after the blasting than they are the first year. The duration of the effect of blasting on the soil has not as yet been ascertained, but experiments indicate that the soil will remain in a shattered, porous condition for a number of years. If proper attention is given to the surface, and heavy, deep-rooted crops such as alfalfa are planted after the blasting, it is quite likely that the soil will not return to its former state within the life of man. The effect of subsoiling is thus virtually to change a farm from a six-inch layer of fertile soil to a six-foot layer.

## Methods of Subsoiling

Subsoil may contain tightly packed earth, or hardpan, in varying positions. Over a large part of the United States there is a reasonably good surface soil underlain by a tight, impervious clay which reaches down to an indefinite depth. When such a subsoil is blasted, the downward movement of water is at once made possible. Instead of being checked at the bottom of the plowed furrow it penetrates immediately into the subsoil, where it can spread out at will and where it will be absorbed and later used to supply the needs of the growing crop. The hardpan is often found in layers within two or three feet of the top soil, separating the surface from an open subsoil beneath. In such a case, blasting not only makes good soil out of the hardpan, but opens up the way to the fertile soil below so that its resources also become available to the plants. A very shallow layer of hardpan, lying close to the surface soil, and extending perhaps no deeper than eight or ten inches, is sometimes formed by the slide of the plow, after years of plowing, and is called plow sole. Occasionally deep hardpan is found below quite a

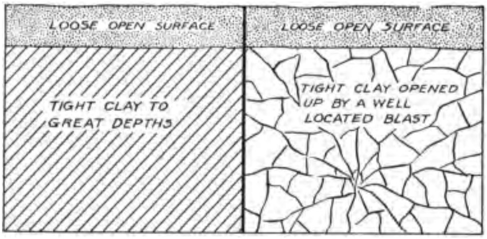

LOOSE OPEN SURFACE
LOOSE OPEN SURFACE
TIGHT CLAY TO GREAT DEPTHS
TIGHT CLAY OPENED UP BY A WELL LOCATED BLAST

FIG. 36. FOR DEEP, TIGHT CLAY, THE BLASTS SHOULD BE NOT LESS THAN 3 FEET DEEP. THE BLASTING SHOULD BE DONE WHEN THE SUBSOIL IS DRY.

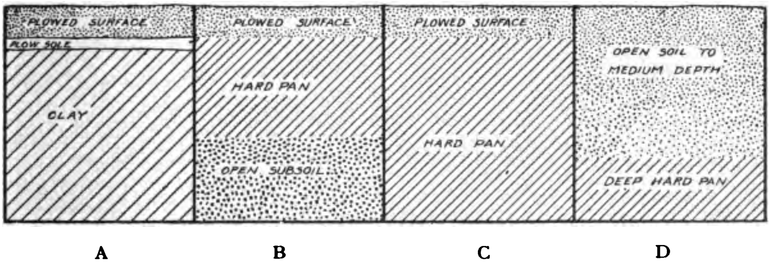


FIG. 37. VARYING CONDITIONS IN WHICH HARDPAN IS FOUND.

depth of well-cultivated open surface and upper subsoil, as is pictured in D of Fig. 37, page 57. The resources of the naturally deep fertile soil can then be greatly increased by creating still more open soil below. A depth of open soil insures good drainage even in case of torrential rains, and stores up enough moisture to last over a prolonged dry period.

When the tight soil is very deep and begins near the surface, the blasting should be done in holes drilled to a depth of not less than three or four feet. In some cases, it is better to go deeper. However, no attempt is made to blast entirely through very deep hardpan, but sufficient room for storing moisture and permitting ample root development is obtained by pulverizing several feet of the top. Each hole should be loaded with a half-cartridge of Red Cross Farm Powder or Dumorite. Directions as to drilling, loading, priming, tamping, and firing are given in earlier pages.

In blasting hardpan where it occurs in layers, the depth of the hole will depend entirely upon the depth of the layer. The explosive must be placed near the bottom of the hardpan so as to pulverize the entire layer. In some cases the holes may be not more than two feet in depth; in others, they may need to be three or four feet. The holes should not extend below the hardpan, however, as the force of the blast will then tend to raise it in chunks, rather than to shatter it.

When the hardpan to be shattered is found below a depth of open soil, the depth of the holes is determined by the depth of the open soil. The holes should extend well down into the hardpan and the amount of explosive usually used should be increased, sometimes more than doubled.

Plow sole is usually best destroyed by deep plowing. However, if it lies deeper than the plow will reach, a deep tillage machine will break up the plow sole and mix with it the better-aerated surface soil. When other impervious soil exists below the plow sole, the underlying hardpan must be blasted.

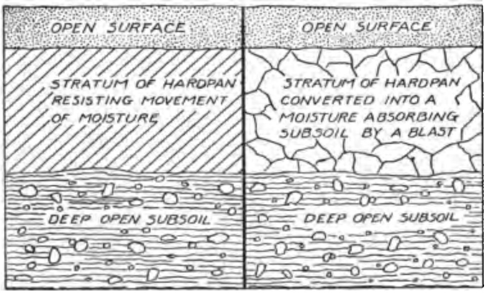

OPEN SURFACE
STRATUM OF HARDPAN RESISTING MOVEMENT OF MOISTURE
DEEP OPEN SUBSOIL
OPEN SURFACE
STRATUM OF HARDPAN CONVERTED INTO A MOISTURE ABSORBING SUBSOIL BY A BLAST
DEEP OPEN SUBSOIL

FIG. 38. A LAYER OF HARDPAN OVER OPEN MATERIAL IS EASILY DESTROYED BY BLASTING. THE CHARGES SHOULD BE PLACED IN AND NOT UNDER THE TIGHT MATERIAL.

To blast hardpan consisting of such materials as cemented gravel or hard shale, it is necessary to increase the amount of Red Cross Farm Powder or to substitute for it 40 per cent. Red Cross Extra Dynamite or Dumorite.

The blasting should be done at the close of the dry season, which ends sometime from July to October. The subsoil is usually in the very best condition for shattering at this time. It will then be able to absorb the heavy winter rains and snows and hold them for future use.

*Subsoil should be blasted only when dry.* Dry soil shatters well when blasted, whereas wet soil is usually plastic and sticky, and difficult to shatter. The blast is likely to form a large pothole or cavity at the base of the blast, if the soil is wet, and to pack the earth even more firmly. General subsoiling should not be done when the surface is frozen.

Farmers are familiar with the advantages to soil of planting deep-rooted crops such as alfalfa. Their roots will open passageways far down into the ground, and by decaying will furnish humus, thus keeping the subsoil open to a good depth, and assisting in creating a reservoir for moisture. The growing of such crops following subsoil blasting is to be highly recommended. It is not economical, however, to plant them for the purpose of loosening tight subsoil, as they then expend energy in trying to penetrate hard soil which should be used for growth and fruition above ground. Moreover, many subsoils are so hard that the roots cannot push through, and, in this case, not only is the soil not benefited by the crop, but the crop is stunted by the struggle for food. But, when these deep-rooted crops are planted after subsoiling, they need waste no energy in trying to find nourishment, and can be of benefit to the soil in keeping it in a shattered, porous, fertile condition.

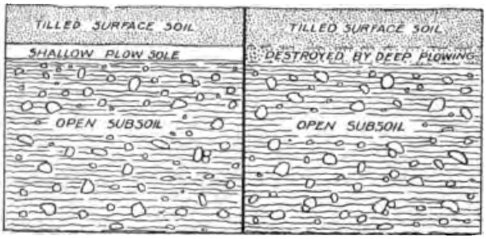
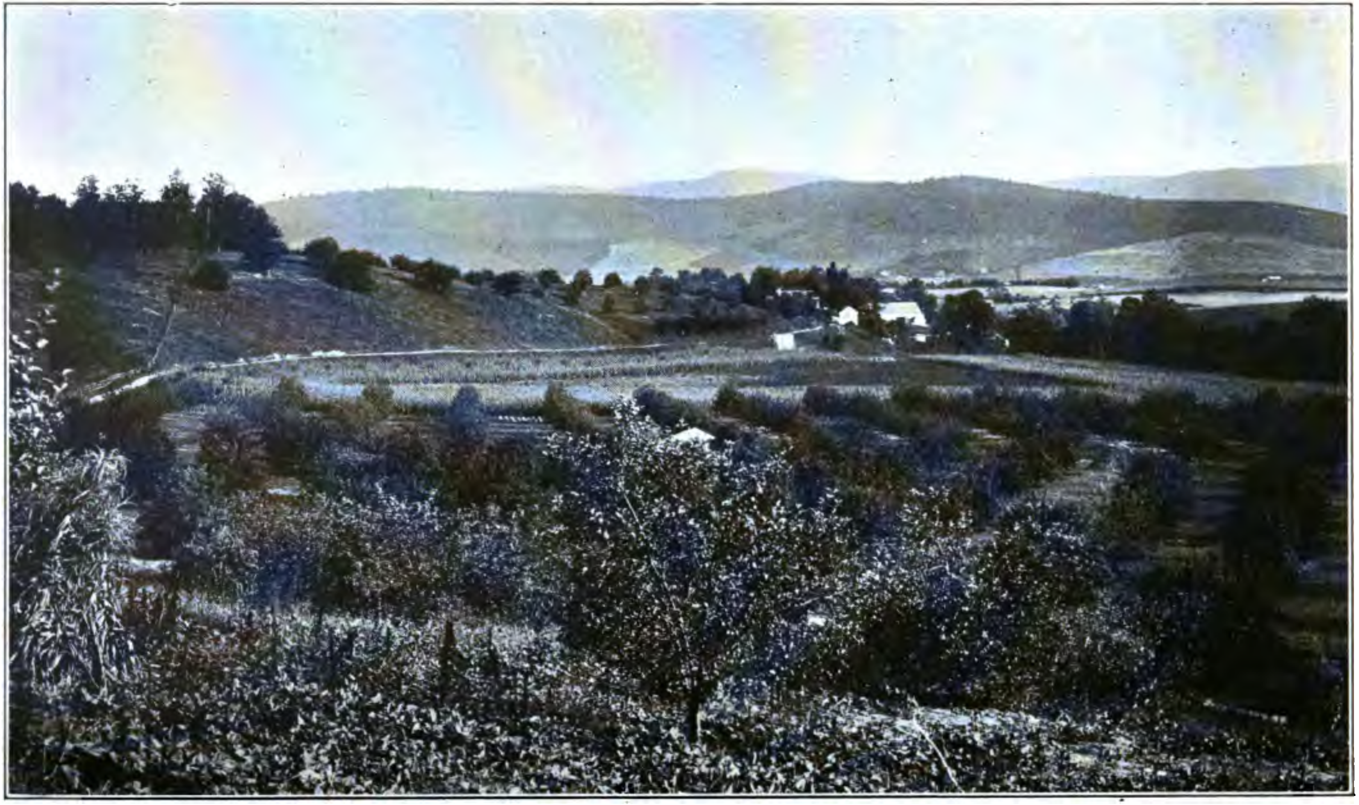


FIG. 39. PLOW SOLE OR SHALLOW HARDPAN IS MOST EASILY BROKEN BY PLOWING TO GREATER DEPTHS. THIS MAY BE DONE IN CONNECTION WITH BLASTING FOR PULVERIZING DEEPER HARDPAN.

The advantages of adding lime to the top soil are also well known. Lime reduces a tight, sticky clay to a well granulated earth. It sweetens a sour soil, and thus assists the growth of bacteria, which store up plant food in the soil, the harmful bacteria being the only ones which thrive in sour soil. It so improves the soil as to make possible a better growth of leguminous green manure crops which, by the humus they supply, make a well-drained, moisture-absorbing, fertile soil. Unless there is an open subsoil, however, benefits to be derived from lime are received only by the top soil. If lime is added after blasting, these advantages can be made available for the subsoil as well.



IN THE SHENANDOAH VALLEY OF VIRGINIA THOUSANDS OF APPLE TREES HAVE BEEN SET IN DYNAMITED HOLES
THUS ENSURING AN EXCELLENT ROOT SYSTEM AND VIGOROUS GROWTH
WITH AN ABUNDANCE OF SUPERIOR FRUIT.

# BLASTING IN THE ORCHARD

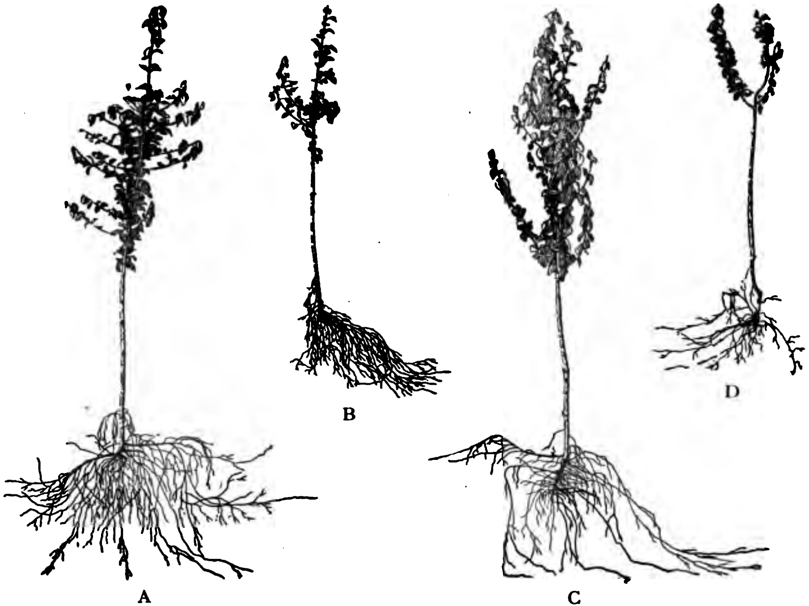
## Tree Planting

In 1910, the du Pont Powder Company began to promote the use of explosives in planting new orchards and rejuvenating old ones. The idea did not originate with us, however. Nearly a quarter of a century ago, an orchardist near La Mesa, California, who found planting in his hard soil with a spade too difficult, tried blasting the holes for some apple trees. His experiment was a success. He discovered that not only was the digging made easier but the trees were invigorated, their development promoted. They thrived and bore exceptional yields for many years. Other orchardists and farmers in different sections of the country tried blasting, and we have records of such plantings, eleven, sixteen, and twenty years before the idea really began to spread. After we began to advertise it extensively and sent demonstrators throughout the country, many tried the plan and discovered its beneficial effects on the trees. Now, because of the universal success in planting millions of fruit, nut and shade trees in blasted ground, the method is widely employed. The majority of fruit trees are being planted by blasting, and American's leading orchardists and nurserymen use this method almost exclusively.

The yields from an orchard are so greatly increased by planting in blasted ground that no one can afford to plant in any other way. By this method the benefits of deep soil cultivation which have been set forth in the chapter, "Vertical Farming," are thus made available for the trees. The soil, when blasted, becomes porous, well ventilated, and well drained. Such a soil permits the moisture from rains to soak in quickly, not only immediately around the hole, but through the cracks in the soil made by the blast into the depths of the earth where it will be stored, to sustain the tree during the dry season. Only when the soil is already open and loose in texture and mellow to a depth of five or six feet, should the planting be done without blasting. In such soil the only advantage of blasting is to destroy fungus or nematode, if present.

At the risk of repetition we enumerate below some of the most important advantages of planting in blasted ground.

1. Makes easy digging the hole and planting the tree properly by mellowing the ground to a depth of five or six feet and throughout a circular area from ten to twenty feet in diameter.



TREES A AND C WERE PLANTED IN BLASTED HOLES. TREES B AND D WERE PLANTED IN UNBLASTED HOLES. THE TREES ARE ALL OF THE SAME AGE. NOTICE RESULTS BOTH ABOVE AND BELOW GROUND.

2. Creates a porous, water-absorbing subsoil that makes the tree drought-proof.

3. Makes available to the tree tons per acre of new plant food.

4. Prevents stagnation of water on the surface by making drainage into the earth possible.

5. Destroys fungus, nematode, and other orchard soil diseases.

6. By aiding growth of roots, speeds up the development and fruition of the tree.

7. Makes possible the planting of new orchards on the land where old ones have been removed without waiting several years to rest the land or to get rid of the diseases.

8. Brings about, at little increase in cost, a year's earlier return on the investment in new orchards, and greatly increased returns thereafter.

Up to a few years ago, the method followed by most good orchardists was to dig a hole seldom as much as 2 feet in diameter and 18 inches deep, and then plant the tree in top soil or a mixture of top soil and subsoil. With this method, the loss the first year ran from 25 per cent. to 50 per cent.

The method of some planters gives the trees even less opportunity to thrive. Although there is no machine for planting fruit trees such as a corn drill for planting corn, their method approximates the work of a machine in speed if not in efficiency. They plow the site for the orchard in cross furrows, marking it off in squares. One man drives along a furrow with a wagon-load of trees, another lays a tree near each of the furrow intersections, and a third stands the tree in the intersections, kicks some soil over the roots, tramps it down, and moves on to the next.

This method expresses unbounded confidence in nature, but results indicate that such confidence is misplaced. A tree that survives such treatment must have as many lives as the proverbial cat. If it lives, how many years must elapse before it bears any fruit and what grade of fruit can be expected from a tree aged with the fight for existence before it saves strength enough to bear at all?

It can be readily seen, then, that, in comparing the costs of the old and modern methods, the ultimate returns from the orchard, not the initial cost, should be chiefly considered. The cost of planting by blasting, including the explosives, blasting caps, fuse, and labor, is somewhat more per hole than the cost of planting with a spade. However, the profit from the increased yields brought about by blasting and the hastening of fruition with the cutting down of first year losses far overbalance the slight increase in cost of planting. Our records show that the yearly saving in replacement and replanting costs alone in young orchards more than balance any expenditure for explosives.

It should be remembered that this method of planting is advantageous not only for orchard trees, but for nut trees, shade trees, berry bushes, vines, roses, and all other kinds of ornamental and commercial trees and shrubs.

**Proper Time to Blast.**—Blasting for tree planting is best done in the late summer because the subsoil is then likely to be in a dry condition. Nevertheless, even though the subsoil is apt to be wet or damp in the spring, it is much better to blast the holes then for spring planting than to plant in dug holes.

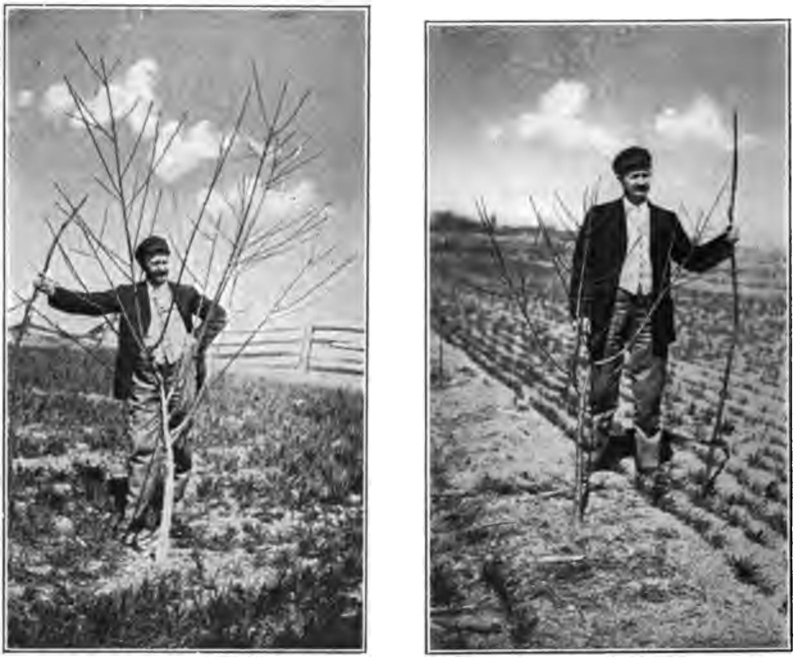
The blasting should be done as many days ahead of planting as possible, to get the effect of air and sunlight in the hole.

**Laying out the Orchard.**—The places to set the trees are selected and marked by a stake, or better, if the field is large, by furrows plowed to indicate the exact lines for the trees, and crossed at the proper intervals by other furrows to indicate the spacing in the rows. Sometimes a heavy cord or light wire stretched across the field will be of assistance.

**Examination of Soil.**—The exact nature and depth of the subsoil should be known in order that the explosive may be used to the very best advantage. The only way to know this is to go down and see. Do not stop at the surface, but go down four or more feet. A good soil auger is the best and easiest tool with which to test a subsoil, but if one cannot be had, dig a hole. A test hole may be blasted out and each layer of the soil examined. This is not so good a way as the others, as the blast so disturbs the subsoil that it is hard to tell just what the original condition was.

**Method of Blasting.**—The nature of the subsoil determines the depth of the holes and the amount of explosives. A condition of soil will probably be found similar to one of those pictured on page 57, in the chapter "Vertical Farming." In this chapter are given also the methods of blasting the various types of subsoil.

The explosives generally recommended for tree planting are Dumorite or Red Cross Farm Powder. On the Pacific coast, Pacific, du Pont or Repauno Stumping Powder is used. One-half cartridge charges are usually sufficient. In the heaviest hardpan or in holes that are deeper than forty inches, larger charges are required.



SET IN BLASTED HOLE. SET IN SPADED HOLE.

SHOWING DIFFERENCE IN GROWTH OF THE SAME KIND OF TREES PLANTED WITH AND WITHOUT THE AID OF EXPLOSIVES.

Directions as to boring the holes, loading, tamping, priming, and firing are given in the preceding pages of this book.

If the holes are deep enough and the loading is properly done, when this charge is fired there is usually only a thud, and a cracking of the surface, with no soil thrown into the air.

A small mound of finely pulverized earth bulged up in the center is an indicator of good results from the blast.

The subsoil will be more thoroughly shattered and the tree derive greater benefit if several charges are used, placed close together.

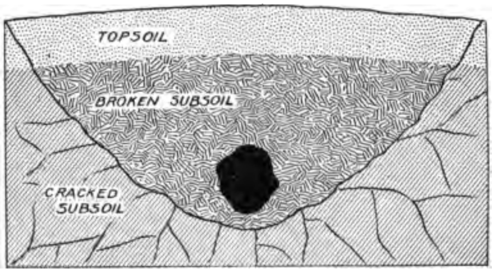


FIG. 40. THE BLAST THOROUGHLY CRACKS THE SOIL, BUT LEAVES A CAVITY OR POTHOLE AT THE BOTTOM. THIS MUST BE FILLED.

**Treatment of Blasted Holes.**—If the holes are blasted in advance of the time of setting the trees they are left without further attention until planting time, unless the soil needs to be enriched. If the soil is poor, manure or other fertilizer should be added to it. If the soil is sour, sticky clay, a few pounds of lime scattered in the hole will assist in loosening the clay and keeping it permanently granulated and sweet.

**Setting the Tree.**—Before the tree is set, the hole must be shoveled out to the very bottom, in order to locate the cavity or pothole which the blast usually leaves there. If this cavity is not filled, the tree is likely to settle too deep after the first heavy rains, and the earth around the roots will drop into the pothole, leaving the roots exposed to dry out. This is the cause of the greater per cent. of first year loss in blasted holes. Opening up the cavity also gives an opportunity to mix fertile soil with the subsoil and to let the sunshine and air permeate the hole.

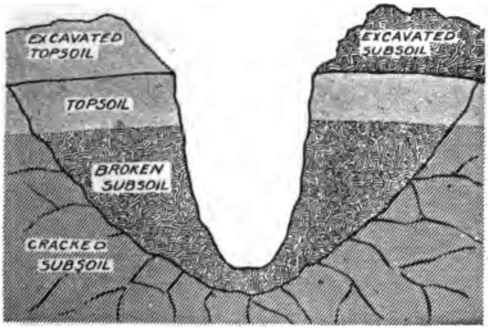


FIG. 41. THE LOOSE SOIL SHOVELED OUT TO EXPOSE THE POTHOLE.

As much of the cavity as possible should be filled with fertile surface soil, and the rest with the subsoil that has been dug out. The filling should be tamped tightly to make firm the base of the tree, and should come up to the level on which the tree is to be set. The tree is then set with the roots spread out in their original position.

After making sure that the tree is in line with the rest of the row, pack in around the roots the top soil that has been shoveled out of the hole (Fig. 42).

## Tree Rejuvenation

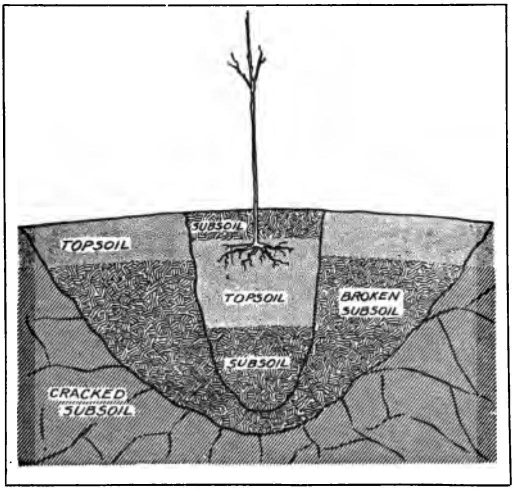


FIG. 42. THE POTHOLE PROPERLY FILLED, AND THE TREE SET WITH ITS ROOTS SPREAD OUT IN THEIR NATURAL POSITION.

Blasting around old trees and vines will open up the subsoil so that the roots may spread farther and go deeper, will make available additional plant food for the roots, establish better drainage and increase the water holding capacity of the soil, and thus lead to more vigorous root growth. Blasting around root-bound trees or in resistant subsoils is strongly advised. In an orchard where trees are set thirty or more feet apart, it is an excellent practice to place blasts midway between the rows, after the trees have been growing several years

Where the subsoils are deficient in plant food or humus, excellent results are obtained by blasting holes and filling them with a soil mixed with fertilizer. The holes are put down a few feet beyond the spread of the branches to a depth of about four feet, loaded, and blasted. The holes are then filled with alternate layers of manure and soil, or with a mixture of manure and a suitable fertilizer (Fig. 43).

Ordinarily it is best to blast on one or two sides of a tree the first year, and on the remaining sides one or two years later. For

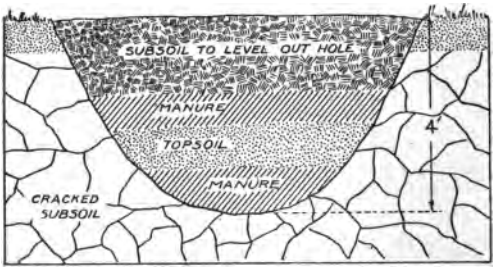
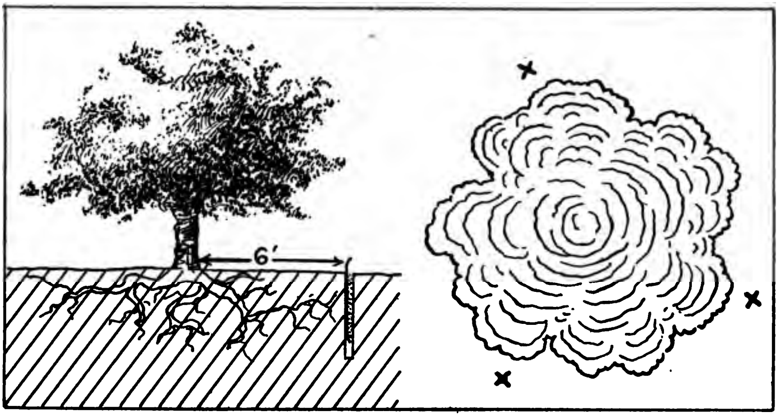


FIG. 43. CRATERS SHOULD BE BLASTED IN POOR SOILS. THEY ARE FILLED WITH ALTERNATE LAYERS OF SOIL AND MANURE OR WITH SOIL MIXED WITH CHEMICAL FERTILIZERS.



For Small Tree For Large Tree

FIG. 44. LOCATION OF CHARGES FOR REJUVENATING TREES.

small trees the blast should be placed not closer than six feet to the trunk. For large trees, they should be slightly beyond the spread of the branches.

When a tree tends to develop a strong tap root, but is stunted by a stratum of hardpan lying immediately under it (Fig. 45), the hardpan can be broken up and the root released by starting a hole two or three feet away from the trunk and driving it diagonally under the tree into the hard material. Great care must be taken, however, not to loosen or blow out the tree. Unless the hole is three or more feet deep the charge should not exceed one-third of a cartridge of Red Cross Farm Powder or Dumorite and not over one-half a cartridge if deeper. Except in

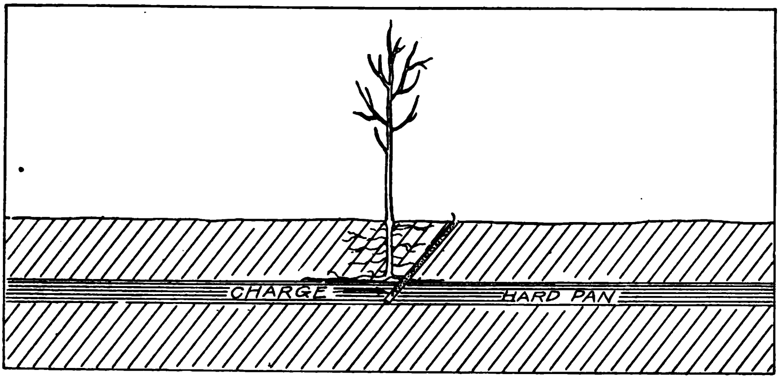


FIG. 45. THE CORRECT LOCATION OF A LIGHT CHARGE OF EXPLOSIVE FOR BREAKING THROUGH HARDPAN THAT IS DWARFING THE DEVELOPMENT OF A TAP ROOT. THE WORK MUST BE CAREFULLY DONE AND THE CHARGE VERY LIGHT.

extreme cases, loading to the side is better. Blasting the hardpan between the trees should be done at the same time.

When blasting around or under growing trees materially prunes the roots, the tops should be cut back to reduce transpiration temporarily so that it will be in proportion to the reduced ability of the roots to obtain moisture. The roots will then grow vigorously and absorb increased amounts of plant food and moisture. The result will be an increased growth of top, and, in case of fruit trees, an increased production of fruit.

(See pages 22 to 30 for methods of loading and firing.)

THIS THRIFTY, ORNAMENTAL SHADE TREE IS A VALUABLE ADDITION TO ADJOINING PROPERTY. PLANTED IN A DYNAMITED HOLE, ITS ROOTS ARE WELL NOURISHED, THUS ENSURING VIGOROUS GROWTH.

# LAND DRAINAGE

The drainage of the wet lands of American farms will produce greater wealth than the operation of all the gold mines in the United States and Alaska. There are more than 75,000,000 acres of swamp and overflowed lands, and more than 100,000,000 acres which need better drainage to put them in a satisfactory crop-producing condition.

The individual tracts needing drainage vary in size from a few square rods in the corner of the farm to tracts of several millions of acres. Practically every farm in the heavy crop-producing areas of the United States needs some ditching, and there is hardly a stream in the entire boundary of the Union that does not need to be corrected to give better service in discharging the large amounts of waste water from heavy rains, and to protect low lands.

The mosquito pests with their attending diseases which render parts of the country almost uninhabitable are the result of poor drainage. The draining of these mosquito breeding areas would increase land values in their vicinity to several times the present selling price.

Good roads which are essential in any prosperous community cannot be maintained without good drainage, as wet roadbeds, no matter what the surface may be, will never stand traffic. In many cases the processes of ditching and road building are carried on hand in hand with the greatest success.

## Ditching with Dynamite

The oldest and best known method of digging ditches is with the pick and shovel. It requires much hand labor and is usually slow and very expensive. When very narrow ditches are needed, as for the laying of underground tile or pipes where the ditches will later be filled with the dirt that has been dug out, either hand or mechanical diggers must still be used, though both are greatly impeded by wet soils, roots, and stumps. While explosives are not recommended for removing the earth from these ditches, they are useful for loosening hard material in order to reduce the cost of the hand work in digging it out.

For large, long ditches, the floating dredge, drag-line excavator, or other heavy digging machinery finds unquestioned use, in connection, often, with explosives for stumping, for boulder and ledge blasting, and for loosening material too hard or too heavy for the dredge to handle economically.

The newest method of ditching, and one that is rapidly growing in use on account of its speed and economy, is blasting. By this means ditches from 2 to 6 feet in depth and from 4 to 15 feet in width can be excavated most satisfactorily in hard, dry soil; in loose and solid rock; in muck and swamp soils—in fact in every type of material from heavy clay to root-infested and water-logged swamp land, except one—that is, loose, dry sand. The advantages of ditching with dynamite are many. It is, first of all, as will be shown hereinafter, a simple and reliable method of digging. It is adaptable to both large and small ditches, and it can be used in places where soil conditions make any other method impracticable. It scatters the excavated material pretty evenly over the adjacent area instead of leaving a large soil pile along the ditch. It is quicker than other methods and requires less labor; it does away with heavy overhead expenses, as no costly equipment is required and the outlay for explosives used can be made only for the exact amount of work to be done; hence it saves both time and money.

LOADING DYNAMITE CARTRIDGES INTO BORE HOLES PREPARATORY TO BLASTING A SECTION OF A DITCH.

There are two distinct methods of blasting ditches, the propagation and the electric. In the former, a line of holes is put down and loaded, but only the central one is primed. When this is fired, the shock communicates itself through the soil from charge to charge and fires each successive hole in the line. As only one hole in the line is fired by the blaster, the cap and fuse method is generally used.

In the latter method, each hole is primed with an electric blasting cap, connected in the circuit, and fired with an electric blasting machine. The propagation method can be used only in wet soils, while the electric method can be used in either wet or dry soils. The explosives and blasting supplies needed and the methods of loading vary considerably in the two methods.

## The Propagation Method

For ditching in wet soils where holes two feet deep will stand half full of water, the propagation method is the quickest and generally the most economical. It can also be practiced in the roughest of swamps, even where there are several inches of water standing on the surface or where the ground is studded with heavy stumps. Unless Du Pont Straight 50 per cent. dynamite is used it should not be attempted, however, when either the air or the water is colder than 50° F.

Du Pont Straight 50 per cent. Dynamite is the best explosive for ditching by the propagation method. Only a straight dynamite, be it noted, can be used for this work, as other kinds are too insensitive to be detonated by the shock from a single primer in a central hole.

**Spacing Holes and Loading.**—The course of the ditch having been decided on in accordance with the surface drainage by a survey or close study of the slope, and the trees having been chopped from the right of way, a few trial shots should be made to ascertain the best depth and spacing for the holes. For ditching up to 3 or 3½ feet deep, the depth of bore holes should usually be about 24 to 30 inches, and the spacing between holes from 18 to 24 inches, although in some cases it may be necessary to increase the depth and decrease the spacing. It is well to begin the test with holes 2 feet deep and 18 inches apart. Ordinarily in swamp soils the bore holes can be put down with little effort. If the soil is at all hard, or has a heavy crust, the fastest tool is a good, sharp crowbar, but if it is soft and mucky, a heavy tamping stick will suffice. The holes should be loaded at once because, if left open, they cave in or become filled with floating slime. Each hole should be loaded with one cartridge and it is well to put one additional

FOR DEEPENING OLD DITCHES, THE EXPLODING OF DYNAMITE WILL BE FOUND BOTH ECONOMICAL AND EFFICIENT.

cartridge in each of the two holes adjoining the central one. After the entire line is loaded, the center hole should be charged with an extra primer cartridge. In making this primer, care should be taken to water-proof both the joints between the cap and fuse, and between the fuse and cartridge. If a little water covers the cartridges in the holes no further tamping will be needed. If not, tamp well with earth.

This loading should lift the soil at least 200 feet into the air, scatter it over the adjoining swamp for a distance of 150 feet and leave a good, clean ditch. If it does not do so, try a different loading. It may be necessary to make the holes deeper in some soils and not so deep in others. Usually in swamp soils the ditch will be excavated a foot or two deeper than the charge, but sometimes it is necessary to punch the holes to the full depth desired.

If the test shot makes too large a ditch, the spacing may be increased a little, but should seldom be greater than 24 inches, and that only in warm soil. Small ditches, about 2 feet deep and 3 feet wide, for instance, in soils where there is little trouble from roots can be dug with half cartridge charges, but for such small loads the spacing between holes can seldom be over 18 inches. Larger ditches can be dug by using two or more cartridges in each hole, and still larger ones, by putting down a second, or even a third, line of holes four to five feet from the first line and loading there in the same way. When two or three lines of holes are used it will be necessary in order to insure the simultaneous detonation of all the charges either to put in one or two extra charges between the rows in a line with the center primed hole, or to prime one hole in each line with an electric blasting cap and fire them all simultaneously with a blasting machine.

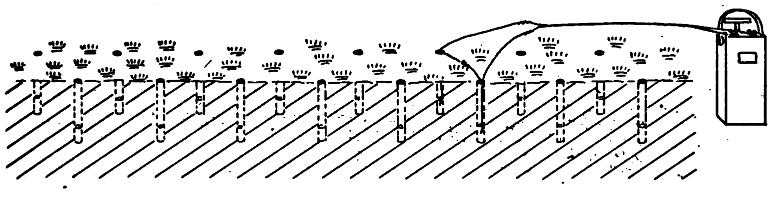


Fig. 46. Showing location of two electric blasting caps in a propagated ditch blast. These are to insure the firing of both lines at the same time. If three lines are used, a third electric blasting cap is put in it. This method of firing is used when a blasting machine is available.

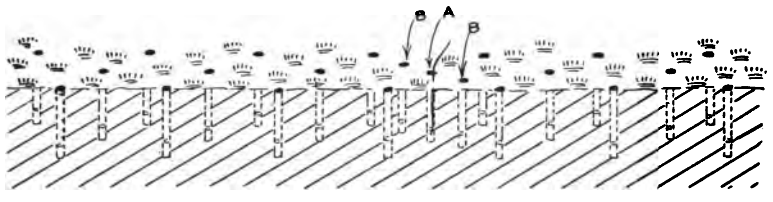


Fig. 47. Showing correct method of locating extra charges—B to carry detonation from the single primer, A, to the outside lines. This is used when no blasting machine is available.

## Table of Approximate Charges of du Pont Straight 50% Dynamite for Blasting Ditches by the Propagation Method

| Top width of ditch in feet | Approximate number of cartridges per hole required for ditches of various depths | | | | Number of parallel rows required | Distance between rows in inches |
|---|---|---|---|---|---|---|
| | 2½ to 3 ft. | 4 ft. | 5 ft. | 6 ft. | | |
| 6 | 1 | 2 | 3 | 5 | 1 | . . |
| 8 | 1 | 2 | 3 | 5 | 1 or 2 | 30 |
| 10 | 1 | 2 | 3 | 5 | 2 | 36 |
| 12 | 1 | 2 | 3 | 5 | 2 | 42 |
| 14 | 1 | 2 | 3 | 5 | 2 | 48 |
| 16 | 1 | 2 | 3 | 5 | 3 | 36 |
| 18 | 1 | 2 | 3 | 5 | 3 | 42 |

The charges given in this table are approximated for holes spaced 16 to 24 inches apart, the exact spacing to be determined, as always, by three or four test shots.

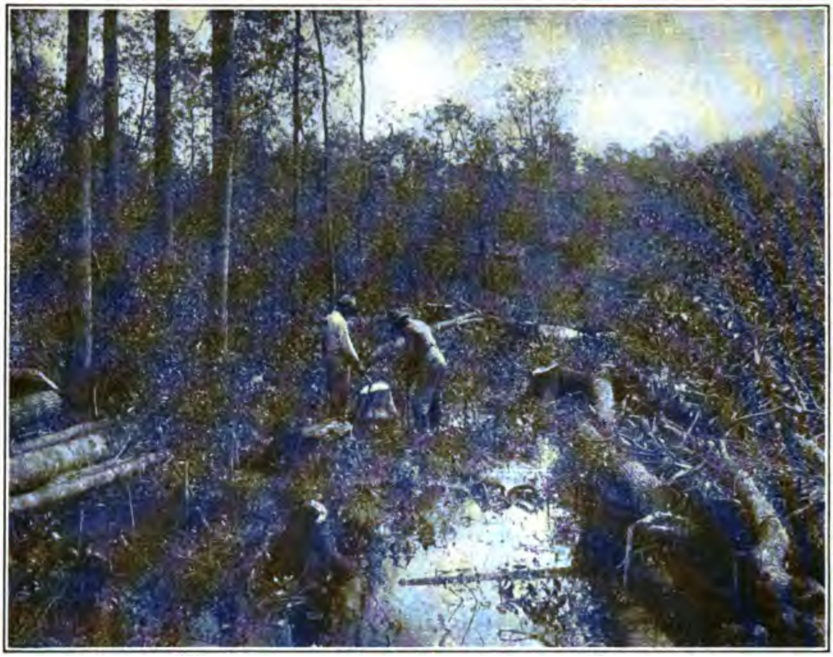
## Quantity of Dynamite Required for a Given Length of Ditch

In order to enable the blaster to calculate the amount of dynamite required to cut various sized ditches, the following table, in conjunction with the preceding table, should prove very useful:

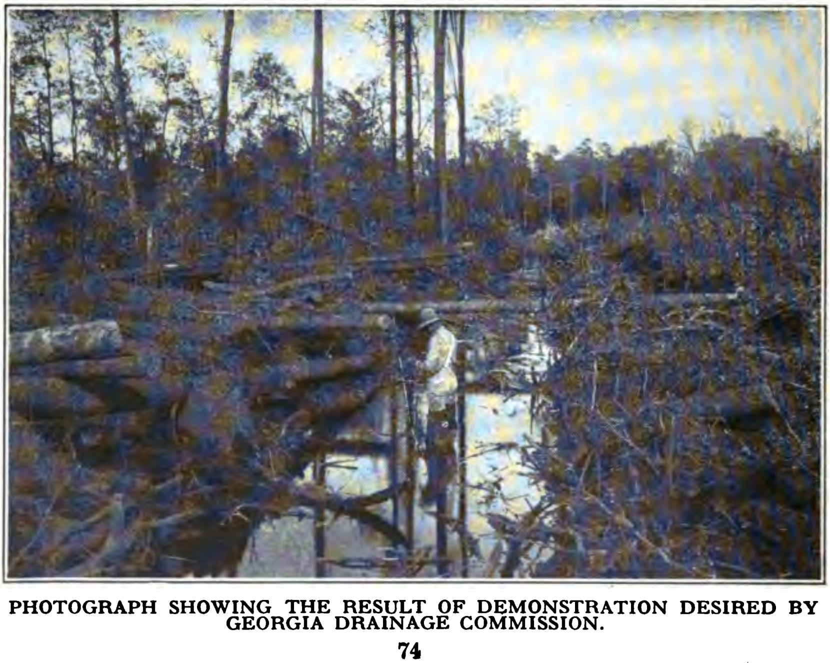
| Spacing between holes in row | 10 Rods | | | ¼ Mile | | | ½ Mile | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of holes | Dynamite required using charges per hole of | | No. of holes | Dynamite required using charges per hole of | | No. of holes | Dynamite required using charges per hole of | |
| | | ½ cartridge | Whole cartridge | | ½ cartridge | Whole cartridge | | ½ cartridge | Whole cartridge |
| 18 ins. | 110 | 28 lbs. | 55 lbs. | 880 | 220 lbs. | 440 lbs. | 1760 | 440 lbs. | 880 lbs. |
| 20 " | 99 | 25 " | 49 " | 792 | 198 " | 396 " | 1584 | 396 " | 792 " |
| 24 " | 83 | 21 " | 41 " | 664 | 166 " | 332 " | 1328 | 332 " | 664 " |
| 26 " | 76 | 19 " | 38 " | 608 | 152 " | 304 " | 1216 | 304 " | 608 " |
| 28 " | 71 | 18 " | 36 " | 566 | 142 " | 284 " | 1132 | 283 " | 566 " |

1 rod— 16½ feet.
10 rods— 165 feet or 55 yards.
¼ mile—1320 feet or 440 yards or 80 rods.
½ mile—2640 feet or 880 yards or 160 rods.

For larger ditches requiring heavier loading or for several parallel rows of holes, increase the total amounts accordingly. These amounts also apply to ditching by electrical firing.



PHOTOGRAPH OF SITE OF DITCH SELECTED BY GEORGIA DRAINAGE COMMISSION TO DEMONSTRATE THE EXPLOSIVE METHOD OF MAKING A DITCH.



PHOTOGRAPH SHOWING THE RESULT OF DEMONSTRATION DESIRED BY GEORGIA DRAINAGE COMMISSION.

**A Typical Propagated Blast.**—The following account of a demonstration of ditch blasting by the propagation method before an annual meeting of the Georgia Drainage Congress illustrates a kind of ditching that is being done all over the country. A difficult location in the swamp land of Georgia was selected for the demonstration because the members of the congress considered ditching with dynamite there an impossible undertaking. The soil was a sandy muck saturated with water and laced together with a luxuriant growth of roots. The surface was studded with large green gum and bay stumps. An idea of the conditions can be gotten from the illustrations on page 74.

The line of the ditch was laid off with a light cord. Holes were punched along this, spaced 2 feet apart, to a depth of 30 inches. Each hole was loaded with two cartridges of dynamite: one 60 per cent. du Pont Straight, the other 40 per cent. Red Cross Extra. A few extra cartridges were put directly under the larger stumps. The blast was fired by the propagation method, using only one cap to each section of ditch.

The result was a clean ditch 9 feet wide and 3½ feet deep, with a bottom almost absolutely true to the desired grade, at a cost of less than 10½ cents per cubic yard. The minimum estimate for hand labor on this job was 25 cents per yard, and it is quite unlikely that the work could have been done at this price.

Following this demonstration, actual ditching with dynamite on a commercial scale was done on neighboring land with results that were entirely satisfactory.

## Ditching by the Electric Method

While it is possible to blast ditches by the propagated method only in wet soils, the electric method can be employed in any class of material, dry sand excepted, and Red Cross Extra or Dumorite can be substituted for the more sensitive Straight dynamite.

**Selection of Explosive.**—The explosive selected for electric ditch blasting will depend upon the soil and the size of ditch. In a medium loam, where only a small ditch (about two feet deep and three feet wide) is desired, the selection may be Dumorite or Red Cross Extra 30 or 40 per cent. Where the material is very sandy du Pont Gelatin 40 per cent. will give best results. It is practically impossible to blast ditches in dry sand.

For larger ditches, or where there is much trouble with stumps and roots, a stronger explosive will give more economical excavation, and Red Cross Extra 40 per cent., Dumorite or du Pont Gelatin 40 per cent. should be selected. Where the work is very wet, and the charges must be left in the water for a long time, the Gelatin should be selected, as it is more water-resisting than the Extra or the Dumorite.

Du Pont Gelatin 40 per cent. also gives the best results in coarse, sandy loam soils.

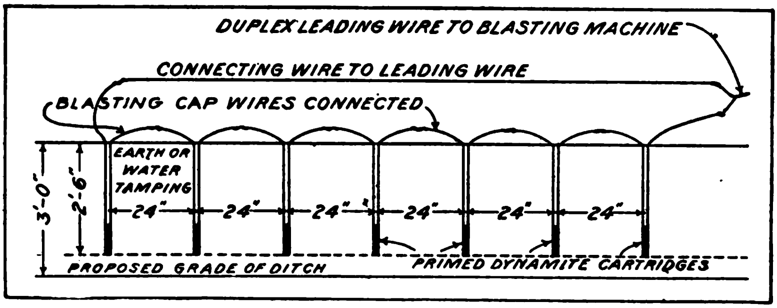
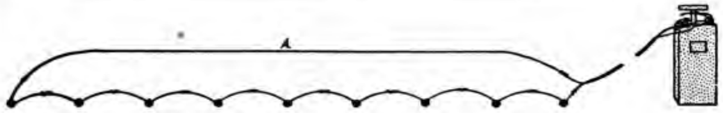
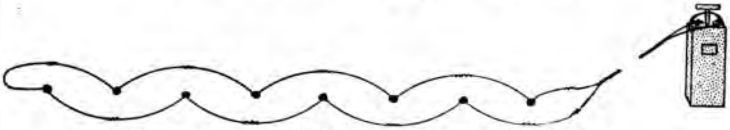

DUPLEX LEADING WIRE TO BLASTING MACHINE
CONNECTING WIRE TO LEADING WIRE
BLASTING CAP WIRES CONNECTED
EARTH OR WATER TAMPING
3'-0"
2'-6"
24"
24"
24"
24"
24"
24"
PROPOSED GRADE OF DITCH
PRIMED DYNAMITE CARTRIDGES

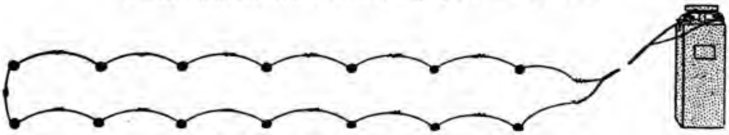
FIG. 49. LONGITUDINAL SECTION, SHOWING METHOD OF LOADING FOR BLASTING A DITCH BY THE ELECTRIC METHOD. THE DIMENSIONS GIVEN ARE RECOMMENDED ONLY FOR MAKING THE FIRST TRIAL SHOTS FOR DETERMINING THE REQUIRED LOADING.



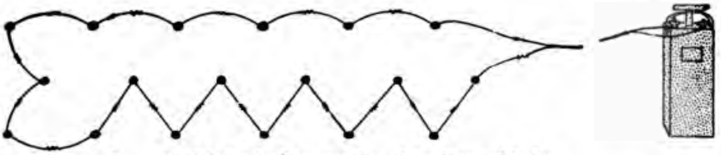
A—Method of connecting up one line of holes



B—Another method of connecting up one line of holes



C—Method of connecting two lines of holes



D—Method of connecting three lines of holes

FIG. 50. FOUR METHODS OF CONNECTING ELECTRIC BLASTING CAP WIRES FOR BLASTING DITCHES. THE BLACK DOTS REPRESENT LOADED HOLES. THE ELECTRIC BLASTING CAP WIRES SHOULD ALWAYS BE LONG ENOUGH TO REACH FROM ONE HOLE TO THE NEXT, AS THIS REMOVES THE NEED OF USING CONNECTING WIRE.

**Spacing Holes, Loading and Firing**—The layout of the ditch is exactly the same as for the other method, but, as an electric blasting cap is used in each hole, it is possible to space the holes farther apart in the row. The normal distances are from 24 to 32 inches for small ditches, and up to 48 and 52 inches for large ditches.

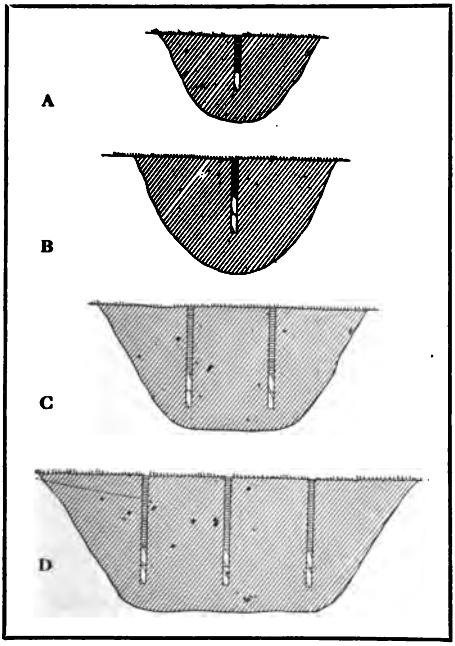
After three or four trial shots similar to those described for wet ditching have established the proper depth and spacing of the holes, and the amount of dynamite per hole, the blaster is ready to begin actual operations. The holes may be put down with a subsoil punch, crowbar, soil auger, or any other tool suitable for the particular class of soil.

It is best to punch only enough holes for one blast, load them and fire before putting down more, as any extra holes are likely to be filled up or covered with earth thrown up by the blast.

When only one cartridge is used in a hole it must contain the electric cap, and should be pressed well down to the bottom of the hole. When several cartridges are used in each hole, the primer should be on top, with the cap pointing downward. All holes, unless standing water covers the charge to a depth of several inches, must be well tamped. (See pages 25 and 26 for methods of making electric primers, and pages 27 and 28 for methods of loading.)

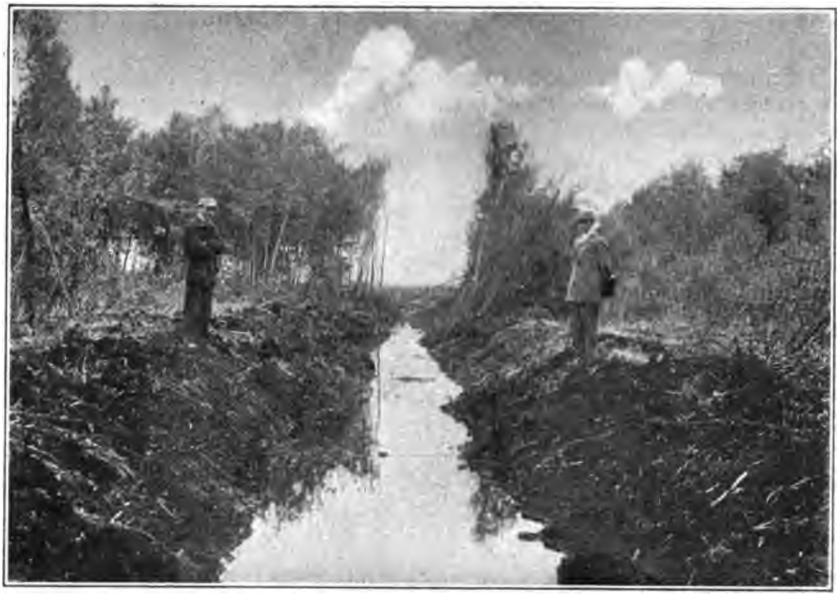
After all the holes for a blast have been charged and tamped, the electric blasting cap wires should be connected with each other and with a blasting machine. Care must be taken not to overload the blasting machine. If its rated capacity is thirty charges, do not attempt to fire more than that at a time.

As the work progresses the soil should be carefully watched, and any needed variation made in the loading so that it may always conform to the material to be lifted.



A—A small ditch requires but one line of holes loaded with light charges—usually one cartridge each.
B—Larger ditches are blasted with a single line of holes containing increased amounts of explosives.
C—For still wider ditches two lines of holes are used. The charges may be of several cartridges.
D—Ditches wider than 12 to 14 feet are usually loaded with three lines of charges.

FIG. 48. VARIATIONS IN THE NUMBER OF LINES OF HOLES AND IN THE CHARGES ARE MADE TO SUIT THE SOIL CONDITIONS AND TO EXCAVATE DITCHES OF DIFFERENT SIZES.



THE DITCH PICTURED ABOVE WAS BLASTED WITH EXPLOSIVES WHICH WERE PLACED AT A CERTAIN DISTANCE APART IN THE NET-WORK OF ROOTS, LOGS AND SUBMERGED STUMPS. THE EXPLOSION MADE THE DITCH AS SHOWN.

THE RICHNESS OF DRAINED LAND AND THE EXCEPTIONALLY LARGE CROPS OBTAINED ARE INDICATED IN THE ABOVE FIELD WHICH WAS FORMERLY A SWAMP.

When larger ditches are desired the loading may be in deeper holes, using more explosive or a higher strength of explosive; or one or two more parallel lines of holes may be employed, especially where wide but shallow ditches are needed. Where very deep ditches are needed, blast a wide, shallow ditch with two or three parallel rows of holes, and then load one or two rows in the bottom of the shallow ditch, and blast another ditch in the bottom of the first one. This latter method has been very efficient in opening large ditches eight or nine feet deep through heavy bottom lands for the correction of stream channels.

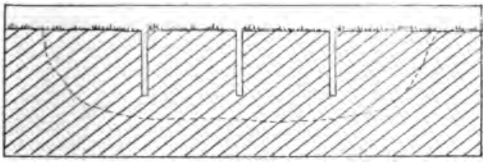


FIG. 51. FOR EXCAVATING THE TOP CUT, THREE LINES OF HOLES WERE SPACED 4 FEET APART EACH WAY. THE DOTTED LINE INDICATES THE DEPTH OBTAINED BY THIS BLAST.

## Table of Charges for Electric Ditch Blasting

| Approximate top width of ditch in feet | Approximate number of cartridges of Red Cross Farm Powder required for various depths | | | Number of rows of holes required | Distance between rows |
|---|---|---|---|---|---|
| | 2½ to 3 ft. | 4 ft. | 5 to 6 ft. | | |
| 3 | 1 | .. | .. | 1 | 0 inches |
| 6 | 2 | 4 | 6 | 1 | 0 " |
| 8 | 2 | 4 | 6 | 1 or 2 | 20 " |
| 10 | 2 | 4 | 6 | 2 | 28 " |
| 12 | 2 | 4 | 6 | 2 | 36 " |
| 14 | 2 | 4 | 6 | 2 | 42 " |
| 16 | 2 | 4 | 6 | 3 | 42 " |
| Required length of No. 6 du Pont Electric Blasting Cap wires........ | 4 ft. | 6 ft. | 6 to 8 ft. | | |

At the 1913 meeting of the North Carolina Drainage Congress an effort was made to straighten a creek. To do this a ditch was needed 8 feet deep and 18 feet wide. The surface soil was light and full of roots. The subsoil was a heavy, wet clay. Three rows of holes were put down to a depth of from 30 to 36 inches, spaced 4 feet apart and loaded with

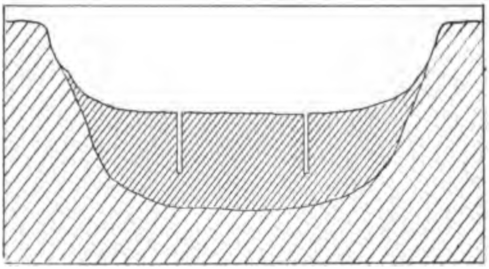


FIG. 52. FOR THE BOTTOM CUT, TWO LINES OF HOLES DOWN TO THE DESIRED GRADE WERE SPACED 4 FEET APART. THE HEAVILY SHADED PORTION REPRESENTS THE EARTH EXCAVATED BY THE SECOND BLAST.

Red Cross 40 per cent. The blast removed the soil to a depth of about 30 inches. In the bottom of this shallow ditch two rows of holes were put down, spaced 4 feet apart, to the desired depth of ditch and loaded a little more than half full of 40 and 60 per cent. du Pont Straight. This blast threw out the soil to the desired depth and left the completed ditch 8 x 18 feet. The cost was between 12 and 13 cents per cubic yard, which was a little high for the work, as the loading was too heavy. For a larger job lighter charges would have been used and a net saving in cost would have resulted. Extreme care in observing the first trial shots should always be exercised in order to keep down the loading as much as possible.

## Costs of Ditching with Dynamite

On account of the variability in ditching conditions encountered, it is rather difficult to give exact information with regard to costs without having first made a careful examination of the soil. However, some description of typical conditions giving the quantity of explosives used in blasting ditches of particular sizes may be of considerable use in estimating final costs.

In swampy ground such as usually prevails along small overflowed streams and in permanent swamps, where the soil varies from muck to wet sand mixed with decaying organic matter, and where the heavy growth of trees is but freshly cut, the use of between three and four 1¼ x 8 inch cartridges of du Pont Straight 50 per cent. Dynamite, in propagated blasts, can usually be depended on to dig one yard of ditch seven to eight feet wide and something over three feet deep. Ditches of this size are proving very useful in correcting streams and for sub-mains in connection with larger drainage channels.

Under the same conditions, charges of the same amount of du Pont Straight 50 per cent. Dynamite, loaded in two rows spaced four feet apart and fired by the propagation method, ordinarily dig a ditch from three to four feet in depth and from twelve to fifteen feet top width. By using three lines of holes with the same loading for each hole, or three times the amount of dynamite given for the small ditch, a ditch of the same depth and from sixteen to eighteen feet in width can usually be obtained.

It may be seen from these figures that the removal of a cubic yard of dirt from the larger ditches where two or three lines of holes are used is slightly more expensive than from the small ditch loaded with one row of charges of Straight 50 per cent. Dynamite. For the small ditches blasted with a single line of holes, it has been found that the least cost, when based on the lineal yard of ditch, is with the lower strength of dynamite, but where larger ditches are needed there is a material saving when the stronger grades are used.

In digging through coarse, sandy loam in a dry section, or sand that is not too dry, three 1¼ x 8 inch cartridges of 40 per cent. du Pont Gelatin fired electrically have in a large number of tests, excavated one

WHEN DITCHES ARE DESIRED WHERE ROOTS AND STUMPS ARE PARTIALLY EXPOSED, EXPLOSIVES CAN BE PLACED EXACTLY WHERE REQUIRED TO SECURE THE DISPOSAL OF ROOTS, STUMPS AND BOULDERS AT A COMPARATIVELY SMALL COST.

running yard of ditch from two and one-half to three feet deep and from four and one-half to six feet wide. This kind of soil is hard to blast, and the work can be done most economically after a period of rain, as the wet soil can be blasted with a smaller amount of explosives, or a larger ditch can be dug with the same amount.

In clay or heavy loam soils that are sufficiently moist to ball a little, the loading just described will blast a slightly larger ditch. For increasing the size of either ditch, two or three lines of holes are used. The increase in the amount of work done and the size of the ditch will be in about the same proportion as that described for the use of additional lines of holes in swamp soils.

For digging very large ditches, as in the correction of wide crooked streams, where two sets of holes are fired in succession to get the desired depth, as described on page 79, the loading varies so greatly even in the course of shooting the same ditch that the cost is difficult to estimate. In easily lifted soil such a ditch will usually require about eight to ten cartridges per lineal yard, but in some of the more difficult soils to blast it will require at least a half more.

## Stream Correction

Each spring the big freshets in creeks and rivers are the cause of much property loss. Bottom lands are either washed away or covered with a layer of sand that is too thick to plow under, and the fertility of the soil is greatly reduced.

Streams overflow chiefly because their channels are full of obstructions. Logs and other floating material form rafts and sand bars. Outcrops of rock divert or impede the normal flow of the current. Overhanging stumps and trees along the banks lend still further obstruction. Sharp bends in the course of the stream check the current and cause the formation of sand bars.

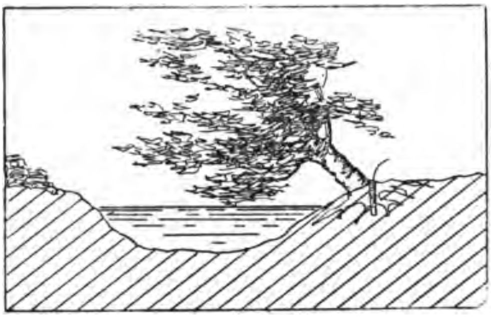


FIG. 53. METHOD OF LOADING A STUMP OR TREE TO BLAST IT FROM THE BANK OF A STREAM. IT IS BEST TO CUT THE TREE OFF FIRST NEAR THE GROUND LINE AND LOAD THE STUMP HEAVILY ENOUGH TO BLOW IT ACROSS THE STREAM. FOR LARGE STUMPS DISTRIBUTED CHARGES AND ELECTRIC FIRING ARE RECOMMENDED.

Any and all of these troubles may be overcome quickly and at reasonable cost by the use of dynamite. It is easy to shoot out the raft and logs, and blast a sufficient channel through the confining rock. (See pages 51 to 54 for methods of blasting boulders and ledges.) A well-placed blast will remove an overhanging stump or tree.

The cutting off of sharp turns in the channel will take a little more time. Locate the line of the new cut-off and blast a ditch that will at all times carry a part of the flow. When this is done and the rafts and logs have been cleaned out of the way above and below the cut-off, all there is left to do is to wait for the heavy rains to flood the streams. The increased rate of flow will cause the water to cut and wear away at the bottom of the channel as well as at the sides. From time to time

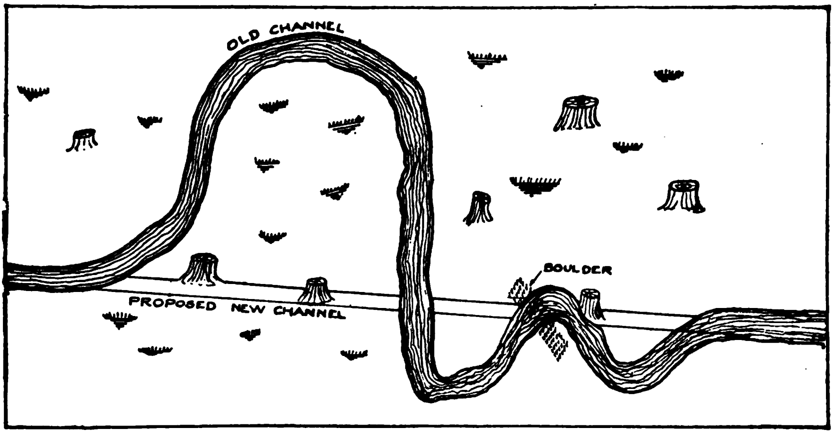


FIG. 54. DIAGRAM OF STREAM TROUBLES THAT MAY BE CORRECTED BY BLASTING.

it will be best to go over the stream and make sure that no new obstruction is being formed. Small blasted ditches have been scoured out by the current until they are now carrying the entire flow of large streams. With a little help now and then any stream with a fair fall can be made to do wonders in making itself a suitable and permanent course.

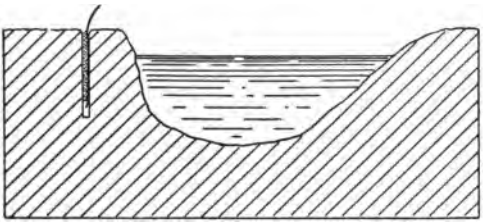


FIG. 55. METHOD OF LOADING FOR WIDENING A STREAM CHANNEL.

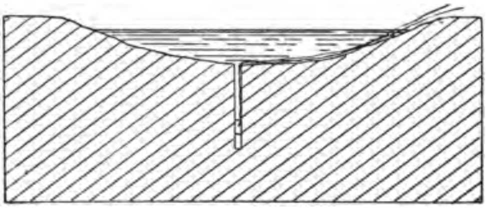


FIG. 56. METHOD OF LOADING FOR DEEPENING A STREAM.

In cases where the stream runs a fairly straight course and it is not necessary to change the bed, it may be desirable to widen or deepen the channel. To do the former, vertical holes should be put down along the bank and loaded heavily enough to blow all the waste material entirely out of the channel. Electric firing is best unless the ground is wet enough to permit the use of the propagation method.

For deepening stream channels, the bottoms of which are too hard to permit erosion, the loading is done exactly as in ditch blasting. The charge must be heavy on account of the added weight of water that must be lifted. Either method of firing can be followed.

# Blasting to Control Erosion

Millions of acres of valuable farm land are continually being damaged by erosion which either carries off the surface soil from a considerable area or wears washouts and gullies. The use of explosives for overcoming erosion is proving very effective and is applicable in four ways: for subsoiling the entire area to increase the total moisture capacity; for blasting along terraces to give the water held by the terrace a chance to strike downward; for subsoiling along the courses of shallow washes; and for blasting to fill gullies.

## Subsoiling Entire Area

Subsoiling the entire area which suffers from erosion during heavy rains permits the water to sink into the ground, thus preventing loss of the fertile top soil and storing up moisture in the subsoil. Blasting for this purpose should be done according to the methods outlined for general subsoiling, pages 57 to 59.

## Subsoiling along Terraces

In many cases high terraces hold considerable amounts of water during heavy rains. This standing water is dangerous because it may either drown the growing crop or so saturate and weaken the terrace that a break is inevitable.

To prevent the water from collecting here it is desirable to blast a row of holes at the base of each terrace as indicated in Fig. 57. This work also should be done in keeping with the general advice on subsoiling given on pages 57 to 59.

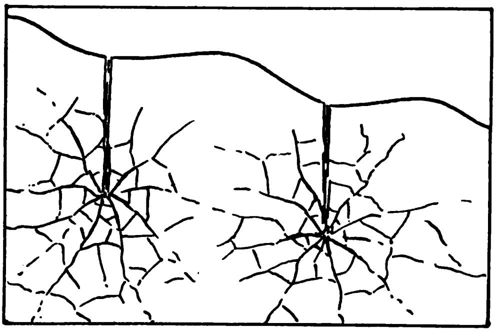


FIG. 57. CORRECT LOCATION OF BLASTS ABOVE WASHES TO CREATE VERTICAL DRAINAGE TO REDUCE THE DANGERS OF EROSION.

## Subsoiling to Stop Washes

Subsoil blasting, slightly heavier and closer than is advised for general work, is effective in stopping shallow washes. The blasting should be started somewhat above the first show of the wash and should be violent enough to shake the subsoil thoroughly to a depth of at least 40 inches, and for at least 15 feet to each side of the wash, as is indicated in Fig. 58.

## Blasting to Fill Gullies

When gullies are too deep to plow across, the banks or sides can be blown down by blasting. The loading may be in vertical holes (A, Fig. 59), or in snake, horizontal or flat holes (B, Fig. 59). Vertical holes are usually best for flat banks and snakeholes for steep banks. They should be deep enough and charged with a sufficient amount of explosives to shatter and throw down the bank so that the work of leveling can be completed with plows or drag scrapers (Fig. 76, page 99). The exact loading must be determined by trial shots. For a gully 6 feet deep, a good trial shot would be with holes 5 to 6 feet apart and about 5 feet deep loaded about half full of Red Cross Farm Powder or Dumorite. The effects of such a blast will

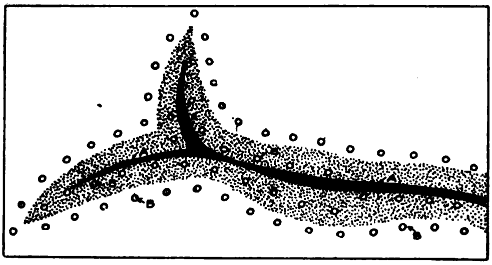


FIG. 58. SHOWING THE LOCATION FOR SUBSOIL SHOTS ALONG A SHALLOW WASH. THE SHOTS ARE INDICATED BY CIRCLES B. THESE SHOULD COMPLETELY SHAKE THE CENTER OF THE WASH A AND SHATTER THE SUBSOIL FOR AT LEAST 15 FEET EACH WAY. FOR NARROW WASHES TWO LINES OF HOLES ARE SUFFICIENT.

GULLIES WHICH MAY BE FILLED BY BLASTING DOWN SIDES OF BANKS.

indicate clearly how the next holes should be spaced and loaded. A satisfactory blast will not only fill the gully but will also shatter the deeper subsoil, so that it will absorb an increased amount of water and prevent further erosion, except under very trying conditions.

As there is sometimes danger of the freshly moved soils being washed away by heavy rains, a good precaution is to build an occasional dam of logs or boulders across the gully—to act as an anchor. Another good anchor is a woven wire fence stretched across the gully, having its top flush with the surface of the ground. A pile of cornstalks, old hay, or brush above either type of anchor helps to guard against sloughing.

Broken boulders, stumps, logs or any other loose material placed in the bottom of the gully before it is filled will have the effect of a deep, well-laid tile drain. Through this the excesses of water will be drained off without injury to the surface. In many cases, it will be well to straighten up the bottoms of the gullies and lay permanent subdrains before the filling is commenced.

For wide, shallow gullies, where the entire surface has been lost, but where the cutting has not been deep, the treatment is the same as deep subsoiling with the spacing of the holes decreased to ten or twelve feet. In filling gullies large amounts of unaerated subsoil are exposed, and care should be taken to add humus either in the shape of rank-growing green-manure crops, vegetable litter, or rough manure. Old cornstalks, forest leaves, or mildewed straw can be used to good advantage.

To derive the greatest benefits from gully filling, the work should be done in connection with subsoiling and terracing along the slopes above the gully, for in this way the water from violent rains is prevented from immediately rushing to the lower slopes, as it is held back and absorbed by the loose, well-broken subsoil. Hence, the newly filled gully is not in danger of being again cut out and eroded by a too sudden flow of a large volume of water.

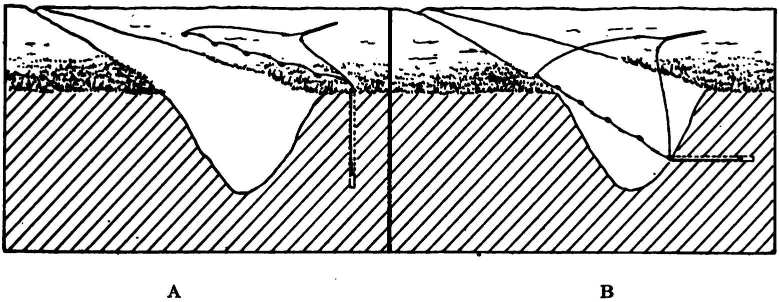


FIG. 59. METHODS OF LOADING TO BLAST DOWN GULLY BANKS. A IS BEST FOR SLOPING BANKS, AND B FOR THOSE HAVING STEEP SIDES. ELECTRIC FIRING IS RECOMMENDED.

## Vertical Drainage of Wet Spots

It is often very difficult to devise a method of draining a land-locked depression. Generally speaking, ditching is the proper solution of the problem, but that is impossible unless there is an outlet and at least some degree of slope. As ponds and wet spots are caused by impervious soil beneath them, blasting this will sometimes establish perfect drainage. Certain conditions must exist, however. First, it must be ascertained by means of a soil auger that there is a stratum of gravel or sand beneath the impervious layer that will carry off the surface water if it is drained down into it.

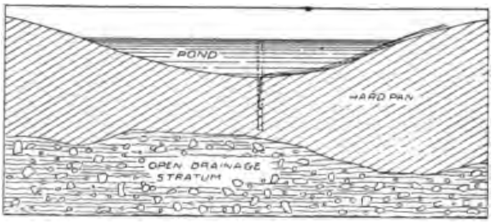


FIG. 60. WHEN PONDS ARE CAUSED BY TIGHT MATERIAL OVER OPEN MATERIAL THEY CAN BE DRAINED BY DEEP BLASTING. NOTE THE LOCATION OF THE EXPLOSIVE CHARGE.

The character of the soil forming the impervious layer must also be noted. If it is shale or a true hardpan that will remain broken up when blasted, the blasting alone, provided it breaks all the way through to the water-carrying stratum of sand or gravel, will prove sufficient to drain the surface. On the other hand, if the impervious layer consists of a fine, sticky clay, it will run together again after being blasted, and the drainage will stop because of the clogging of the outlet. In this case it is necessary to blast out a rough well or sink hole reaching down to the open soil, and to fill it with trash which will prevent the clay's running together again. If the stratum of sand or gravel lies over thirty feet below the surface, this method of drainage is impractical.

In order to blast the well, a bore hole must be put down within about a foot of the sand or gravel. It should be started at the lowest point in the surface, that is, the point to which surface water would naturally run. The hole is bored with a dirt auger, which should be pulled up from time to time in order to clean out the hole, and also to ascertain the nature of the soil clinging to its spiral thread. When this soil indicates that the water-absorbing sand or gravel is reached, the hole is tamped full of soil to about 6 inches above the sand or gravel, if shallow, and from 12 to 18 inches, if deep. This is done because it is not advisable to load the charges in the sand or gravel. They should be located in the hardpan stratum.

At the bottom of the bore hole a chambering shot should first be made by using a cartridge or two of dynamite. In the chamber thus formed a load of from five to twenty-five pounds of 40 per cent. dynamite (the amount depending upon the depth of the hole) should be placed. Cartridges should also be strung all the way up the bore hole to within about two feet of the top. As the cartridges will all be in contact, one primed cartridge at the top of the line will fire the entire charge. The shot should form a rough well from the surface down to the sand. If the soil is a wet, heavy clay, it should not cave much. This well or sink hole should then be filled with cinders, loose stone, stump fragments, or any trash that will keep it open. Such a sink hole should drain the pond or wet spot.

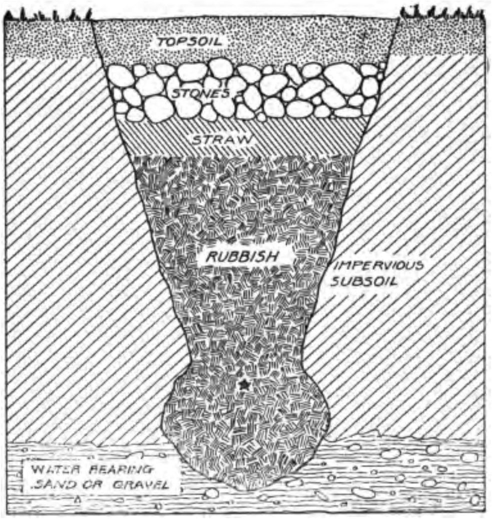


FIG. 61. DIAGRAM OF DEEP DRAINAGE HOLE SHOWING THE USE OF TRASH TO PREVENT THE HOLE BECOMING CLOGGED WITH FINE CLAY. THE BLASTED CRATERS MUST EXTEND THROUGH THE CONFINING HARDPAN OR CLAY AND INTO OPEN WATER BEARING MATERIAL BELOW.

If the wet spot is a large one covering considerable area it will probably be necessary to construct several sink holes in the bottom in order to get good drainage. In this case, a test hole is first bored to determine the necessary depth for the holes. When the auger reaches the open soil, the depth is marked in the auger shank.

When, as often happens, holes have to be bored to depths averaging from 15 to 30 feet before the water-absorbing strata are reached, it is necessary to use an extension auger or long churn drill. If the water is too deep to work in, the boring should be done from a raft. In boring from a raft, it is much easier to operate the auger through a hole in the center of the raft than over the side.

As soon as the hole has been bored to the required depth, the auger is withdrawn and a piece of 1½-inch pipe, sufficiently long to reach the bottom of the hole and 5 or 6 inches above the water level, is inserted. Through this the dynamite cartridges are dropped one at a time and pushed to the bottom with a wooden tamping rod. A good, firm push will hold each cartridge in position. The last cartridge but one is primed with a du Pont Waterproof Electric Blasting Cap. One cartridge is put on top of the primer to hold it in place, as it should not be given too hard a push with the tamping rod. If the holes are filled with water, it is unnecessary to do any tamping. In this work, the cartridges should not be slit.

When the hole has been charged, the loading pipe is withdrawn and slipped over the ends of the electric blasting cap wires, the leading wires are connected onto the electric blasting cap wires, the joints being carefully protected with insulating tape, and the raft is poled to the shore or a safe distance away from the hole while the leading wire is carefully paid out. The outer ends of the leading wires are then attached to the blasting machine, and the machine operated.

The explosive to be used is Red Cross Extra Dynamite 40 per cent., or du Pont Gelatin 40 per cent. The following table gives the approximate charges for holes of different depths:

| Depth of hole | Approximate number of 1¼" x 8" cartridges |
|---|---|
| 5 feet | 5 |
| 10 " | 12 |
| 15 " | 20 |
| 20 " | 25 |
| 30 " | 40 |
| 40 " | 50 |

Where the ground is swampy or ponds form in the wet season only and dry up later in the year, the blasting should be done in the dry season when a raft will not be required. Under these conditions, the blasting should be done just as described above except that it is necessary to tamp the charge thoroughly unless the bore holes fill up with water. In this work it is sometimes of advantage to make a chamber in the bottom of the hole by first exploding a single cartridge in the bottom, for this makes it possible to get more of the main charge into the bottom and break the rock or subsoil more thoroughly. The explosion of the single cartridge may close the hole a little, but it can easily be opened again with the auger or an iron rod. The main charge must never be loaded immediately after chambering, but a half hour or more should be allowed for the bottom of the bore hole to cool off. This plan of chambering the bottom may also be followed when water fills the bore holes.

# Miscellaneous Uses of Explosives

## Road Building

A rational use of explosives in road building for clearing the right of way, blasting protruding stone from the surface or from the sides of cuts, making cuts through stone or tight clay, digging ditches, reducing

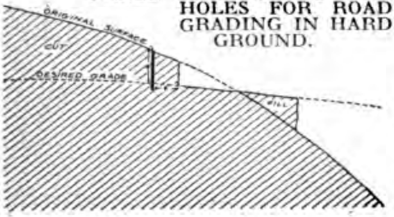


FIG. 62. LOCATIONS OF BORE HOLES FOR ROAD GRADING IN HARD GROUND.

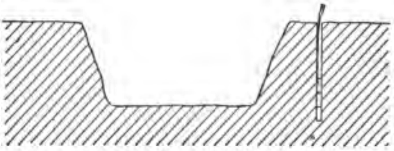


FIG. 64. METHOD OF LOADING TO WIDEN A ROAD CUT.

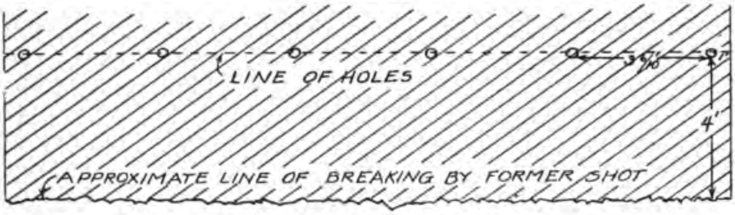


FIG. 63. PLAN OF APPROXIMATE LOADING FOR CUT WORK.

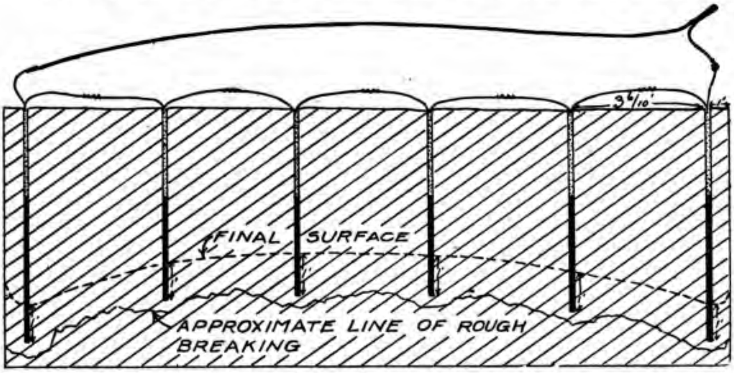


FIG. 65. APPROXIMATE ELEVATION OF LOADING FOR CUT WORK.

grades, widening cuts, and various other purposes, will hasten the completion of the work and reduce the cost. Electric firing is recommended for all of this work.

The methods already described for stumping, boulder blasting, and ditching are equally applicable to this class of work. The loosening of tight clays in reducing grades is done in exactly the same way as in digging cellars described under "Excavating Cellars and Foundations."

In starting in a rock cut the ordinary practice is to drill the holes a few inches below the desired grade. These holes should be spaced back and apart a distance about equal to the depth of the cut, unless the holes are more than six feet deep. In that case the spacing should be about six feet. Each row of holes should be fired simultaneously with electric caps and a blasting machine.

Our book, "Road Construction and Maintenance," gives detailed information on road building. A copy may be had on application.

## Blasting Post and Pole Holes

To speed up the work and decrease the cost, many post and pole holes are now blasted. The method employed will depend on the depth of the holes and the nature of the ground. The methods given below for deep and shallow holes are useful only in clayey soils, or other soils that can be packed by the explosion. Shales must usually be blasted by the method given for blasting holes in rock.

When the ground is hard below the surface, first remove the soft top soil to a depth of from 6 to 8 inches, or down to the hard ground, and to the full diameter of the desired hole. This will prove helpful for both deep and shallow holes even where there are but a few inches of soft ground. The hole is then ready for punching the bore hole for loading.

RESULTS OF A BLAST FOR A DEEP HOLE. THE SURFACE WAS NOT BLOWN OUT, BUT WAS SLIGHTLY RAISED. BELOW, A DEEP AND WELL-SHAPED HOLE WAS FOUND. THE COST WAS REDUCED ABOUT 50 PER CENT. OF THE COST OF HAND-DIGGING.

The bore hole should be located in the center of the shallow hole already shoveled out. It should be 1½ inches in diameter. Where deep holes are needed it should be 2 inches in diameter, as there must be room for loading the long charge of dynamite.

The method of punching the bore hole depends on the nature of the ground. In clay it may be easily put down by means of a long churn drill, using a little water. For harder ground a heavy drive point or drill can be driven down and loosened by pounding on the sides, so that it can be easily removed.

The use of a soil auger is often required for finishing the bottoms of very deep holes where churn drilling or punching is difficult. Holes can be made entirely by the use of the auger, but this is usually more expensive than punching. When the soil is too dry to stick to the auger, a little water should be poured into the hole. This forms mud that can be easily lifted out.

Hard shale and rock require the use of rock drills.

Frequently pebbles or clods fall into the bore holes before they are loaded. These, naturally, prevent the charge from being correctly placed, and so must be removed. The best tool for doing this is a spoon, such as is shown in Fig. 4. The spoon is useful in both deep and shallow holes.

## Blasting Shallow Holes

Shallow holes are ordinarily blasted by using a half, or, if the ground is very hard, a whole cartridge of Dumorite, Red Cross Farm Powder, or Red Cross Extra Dynamite from 20 to 40 per cent. The cartridge is primed and loaded in the bottom of the bore hole, usually without tamping. (See pages 22 to 26 for methods of making primers.) Either blasting caps and fuse or electric blasting caps may be used.

The effect of such a blast is to force back the soil and form a pothole at the bottom, and to loosen the soil above so that it may be easily spooned or shoveled out. This obviates the necessity for using a chisel or other tools to loosen the hard ground. If it is wet or moist when the blasting is done, the greater part of the ground is packed back into the wall and bottom. Some loose soil is usually left at the bottom of the hole.

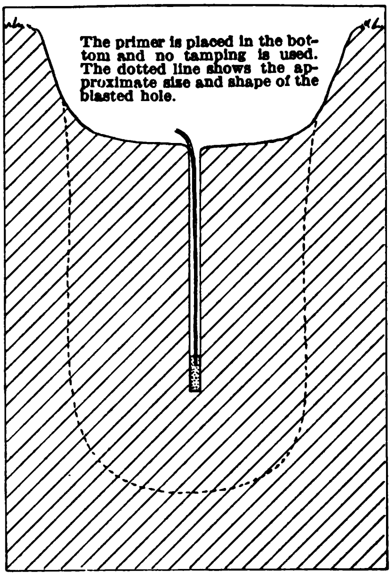

The primer is placed in the bottom and no tamping is used. The dotted line shows the approximate size and shape of the blasted hole.

FIG. 66. METHOD OF LOADING FOR BLASTING A SHALLOW POLE HOLE.

## Blasting Deep Holes

The method of loading must be changed for deep holes, as the one just described will leave a tight bridge or plug of dirt at the top. To prevent this, the charge is distributed along the hole as is shown in Fig. 68 in order to get more uniform lateral expansion of the gases.

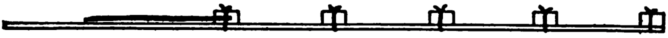


FIG. 67. DYNAMITE CHARGES TIED TO STICK AND READY TO LOAD FOR A POLE HOLE BLAST

Use a straight, narrow lath, reed, or stick, as long as the depth of the hole. Cut the cartridges into two or three pieces. Tie one piece of dynamite to the side of the stick at one end, and from 6 to 10 inches further up tie a second piece. Continue this to within from 12 to 24

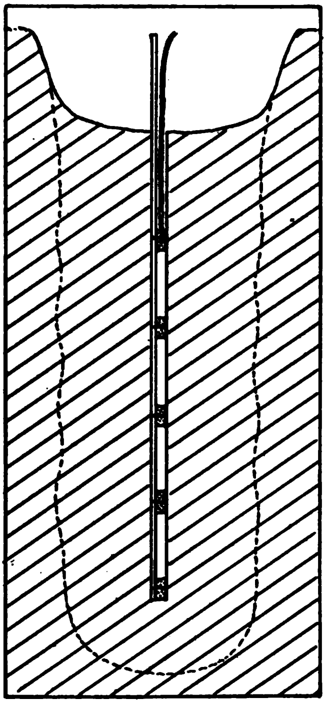


FIG. 68

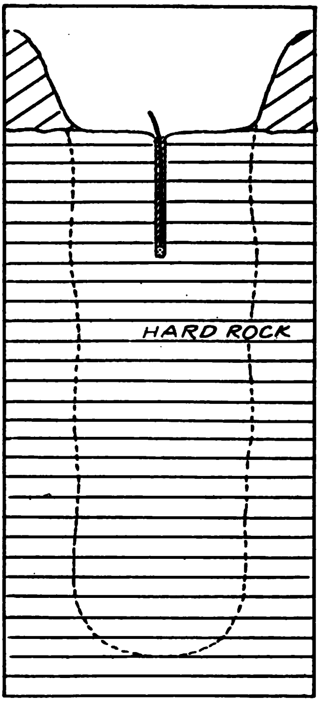


FIG. 69

FIG. 68. METHOD OF LOADING FOR BLASTING A DEEP POLE HOLE, SHOWING THE DISTRIBUTED CHARGE IN PLACE. THE DOTTED LINE INDICATES THE APPROXIMATE SIZE OF THE FINISHED HOLE.

FIG. 69. METHOD OF LOADING FOR BLASTING A POLE HOLE IN HARD ROCK. DOTTED LINE INDICATES THE SHAPE OF THE BLASTED HOLE.

inches of the top, depending on the nature of the soil and the results of trial shots. The charge thus arranged is placed in the hole with the primer end up and fired.

The amount of dynamite in each charge must be governed by the strength of the dynamite and by the hardness of the ground. The need of tamping above the primer will depend on the nature of the soil.

## Blasting Holes in Solid Rock

As it is impossible to force back the sides of the holes in solid rock, as is done in blasting in hard clays, modifications must be made in the method of loading.

Ordinarily holes are not put down so deep in rock as in hard ground. After excavating the hole down through the soil, if any is present, drill a hole from 12 to 18 inches (Fig. 69) into the rock. Load this with a full cartridge primer pressed well to the bottom, tamp the hole tight, and fire. If the loading is heavy enough this will shatter the rock to the full depth of the blast.

When the loose fragments have been removed, drill another hole to about the same depth and load as before.

The explosive used for this work should never be of a lower strength than Red Cross Extra 40 per cent. and for hard rock 50 to 60 per cent. strength is often better.

## Sinking Wells

Wells are often sunk through rock or ground which cannot be dug to advantage without the aid of explosives. When rock is reached and the earth above is properly supported, a circle of four or five drill holes should be started about half-way between the center and the sides of the well and pointed at such an angle that they will come closer together near the center when they are three or four feet deep (Fig. 70). These holes should be loaded about half full of du Pont Gelatin or Red Cross Extra Dynamite 40 per cent., with damp clay or sand tamping packed firmly above to the top of the hole and then exploded all together from the surface by electricity. This shot will blow out a funnel-shaped

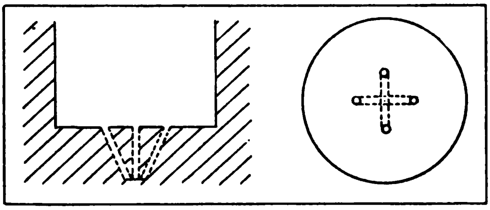


FIG. 70. THE FIRST OR CUT HOLES ARE DRILLED NEAR THE CENTER OF THE WELL, AND SHOULD NEARLY MEET AT THE BOTTOM.

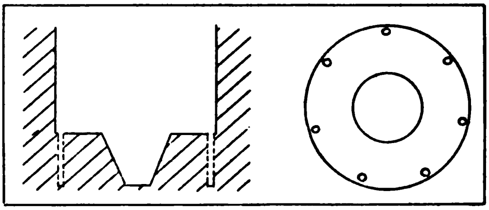


FIG. 71. WHEN THE FIRST HOLES HAVE BROKEN OUT A CONE-SHAPED CUT, THE WELL IS WIDENED TO ITS FULL DIAMETER BY ANOTHER ROUND OF SHOTS DRILLED PRACTICALLY STRAIGHT DOWN.

opening in the center, and the bottom can then be made full size with another circle of holes drilled straight down as close to the sides as possible (Fig. 71). If the well is large it may be necessary to drill a circle of holes between the inner and outer circle. The above process should be repeated until the well has passed through the rock or has been sunk to the necessary depth. Do not in any case enter a well until all the fumes of the last blast have come out. If in doubt, lower a lighted candle to the bottom; if it continues to burn, the well may be entered safely. Electric blasting caps will give the best results.

## Shooting Wells to Increase the Flow of Water

Often drilled or dug wells do not give a sufficient flow, the water being confined in a number of small veins or fissures that do not discharge into the well. The object of shooting a well is to open up these veins or fissures so that all of the confined water is brought together and the flow is increased. Where wells are drilled in dry, non-water-bearing rock, shale, clay, or gravel, shooting will not produce a flow.

Well shooting should never be attempted by the novice in the use of explosives. The services of an experienced well shooter should always be secured. The du Pont Company will be glad to correspond with those having work of this kind to do who cannot get the services of a competent shooter. In writing us be sure to give all of the information following:

### For Drilled Wells

1. Location of well. 2. How many feet distant from nearest buildings?

3. Kind of buildings. 4. Diameter of well in inches.

5. Diameter of casing in inches. 6. Depth of well in feet.

7. Depth of casing in well, in feet. 8. How many feet of water in well?

9. Describe the different kinds of soil, rock, and other material you went through in drilling the well, and give the location and depth of each class of material.

10. Can the water be partially or entirely exhausted from the well?

11. What is the maximum number of gallons of water the well will furnish in an hour?

### For Dug Wells

1. Depth of well. 2. Diameter of well. 3. Type of curbing.

4. Character of rock below the bottom of the well.

5. Has the well always given a poor flow or has the trouble developed recently?

6. Are there any neighboring wells on land as high as yours that are giving a good flow? If so, how deep are they?

## Blasting to Make Drains Efficient

When a tile drain is prevented from functioning properly by tight clays and hardpan soils which establish drainage courses slowly, if at all, the drainage can be greatly improved by shattering the subsoils between the lines of tile. Blasting will make drainage possible also in soils that are but little affected by open drains, where the water is held in too large amounts over the subsoil quite near the drains.

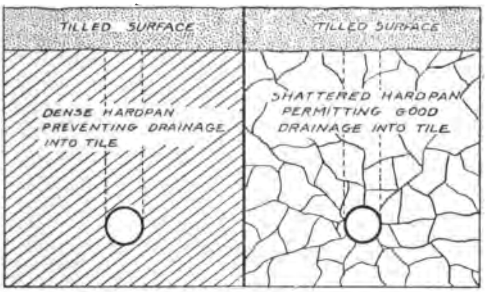

TILLED SURFACE
TILLED SURFACE
DENSE HARDPAN PREVENTING DRAINAGE INTO TILE
SHATTERED HARDPAN PERMITTING GOOD DRAINAGE INTO TILE

FIG. 72. OPENING UP DRAINAGE COURSES BY BLASTING HARDPAN WHICH PREVENTS THE DRAINAGE WATER FROM PASSING INTO TILE OR OPEN DRAINS.

Care, however, must be taken not to blast nearer than seven or eight feet to a tile drain. The best practice is to blast such soils thoroughly before the tile is laid. This prevents all danger of injuring the tile.

## Excavating Cellars and Foundations

When it is necessary to make such excavations in rock, the first or cut shot should be made with a circle of holes running down to a point, as has been described for well sinking (page 93). After one small section is down to the required grade, the rest of the holes should be drilled straight down. These should be spaced back a distance equal to the depth of the cut and about the same distance apart. When the cut is more than six feet deep, the spacing should not be as great as the depth, as more than six feet is hard to blast off.

In reasonably hard rock the drill holes should be loaded a little more than half full of Red Cross Extra 40 per cent. or Dumorite. The cartridges should be slit and tamped tightly. Better results will be obtained with electric blasting, because then several charges can be fired together, giving a cumulative effect.

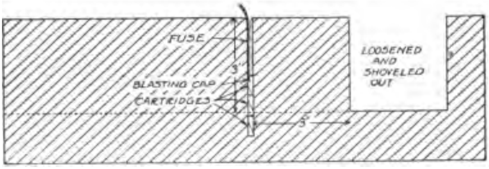


FIG. 73. METHOD OF LOADING FOR EXCAVATING CELLARS AND OTHER PITS.

In tight clay an opening can be started with a single hole not quite down to grade and loaded with enough dynamite to blow out a conical-shaped section of earth. After this is cleaned out, the rest of the holes can be loaded with lighter charges.

See pages 27 to 30 for correct methods of loading and firing.

A HEAVY METAL RETORT THAT WAS BROKEN UP BY A BLAST.

## Scrapping Old Machinery

Breaking up old machinery, such as heavy castings or steam boilers, can be readily done with dynamite.

For scrapping a boiler use only 40 per cent. straight dynamite or stronger. Remove the dynamite from the shell and distribute in a continuous cord about half an inch in diameter all the way around the boiler, and secure it with a heavy mudcap. The dynamite can be placed along one of the seams more easily than on the smooth plates. When detonated such a charge will cut the plates almost as neatly as a shearing machine, and will reduce the cumbersome boiler to a size that can be handled.

For breaking heavy castings mudcapping is practiced in the same way as on boulders (Fig. 53). Sometimes a hole in the casting can be used for a block hole and loaded as described on page 51.

Large vessels and even boilers can be broken up by first filling them with water, and, if possible,

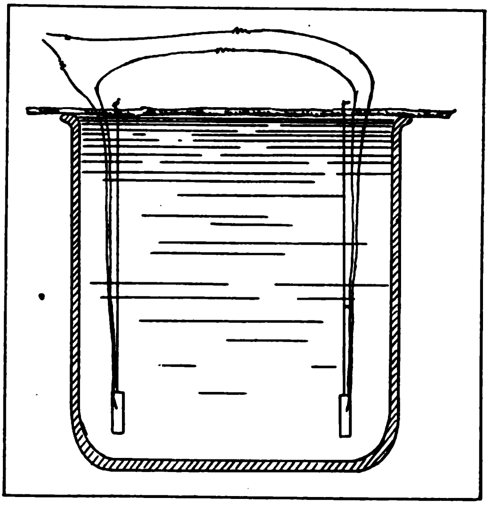


FIG. 74. SHOWING BURSTING CHARGES IN A LARGE VESSEL FILLED WITH WATER. THEY ARE SUSPENDED ON CORDS SO THAT THEY DO NOT TOUCH THE METAL.

closing all openings. The dynamite is primed and suspended in the water near the bottom or near the thickest metal, but must not be in actual contact with the metal. It should be fired by electricity. The explosion of such a charge transmits a powerful blow to all sides and shatters them. (See Fig. 74 for diagram of loading.)

## Starting Log Jams

To start log jams with dynamite, the charge of several cartridges, or in some instances of many pounds of dynamite, is exploded on or under the logs forming the key of the jam. When small charges are enough, the cartridges are tied in a bundle as when blasting ice. If charges of fifty pounds or more are necessary the dynamite may be put in a bag or left in the original wooden cases. The charge is primed with an electric blasting cap and, after being firmly secured in the proper position, is exploded from the shore with a blasting machine.

Blocks in log rollways, caused by the logs being bound together by the freezing of rain or snow, are broken up by exploding charges of dynamite in different places under the logs until they are loosened and can be rolled apart.

Red Cross Extra Dynamite 40 per cent. is recommended for starting log jams and for opening the rollways.

BLASTING OUT A LOG JAM WITH DU PONT DYNAMITE.

# Ice Blasting

Often in spring when ice in streams starts to move, it gets choked by narrow places in the stream or by some natural or artificial obstruction. Then an ice gorge or jam is formed which causes the water to back up, flooding the surrounding country above and often carrying away bridges and other structures and causing considerable damage.

By the use of explosives at the proper time the damage can often be averted. Ice begins to move out in various localities about the same time each year. Usually several days' thawing or rain warns one of the coming break. It is a good plan to anticipate the moving out as soon as the spring thaw begins by blasting the ice while intact on that section of the stream where the gorge or choke usually occurs.

The method of procedure is as follows. With ice spuds or cutters and bars, chop holes about six inches to eight inches in diameter through the ice to the water. Holes should be spaced from fifteen to twenty feet apart. A charge of from six to eight cartridges (if the ice is thick a greater number) of low-freezing explosives 40 per cent. strength should be lowered in each hole so that the explosive is in the water and below the ice. It has been found that because of the wave action the ice is broken up more when the charge is fired in the water than when the charge is imbedded in cracks or holes dug in the ice. The cartridges can be tied together in a bundle, and one cartridge of each bundle should be primed with a No. 6 electric blasting cap. To prevent the loss of the charge the wires can be fastened to a stick of wood laid across the hole on the surface of the ice. Several holes should be connected together in series and fired with a blasting machine and electric blasting caps. The firing can be done by cap and fuse, but as with this method only one hole at a time can be fired, it is best to fire electrically.

If this is done all through the narrow section of the stream the ice is practically "honey-combed," so that when the water and ice from above come down it gives way readily and causes no damage.

If the gorge or jam has actually formed, a charge of from five to twenty-five pounds (in some cases much more) of dynamite should be loaded in a crevice, or dug hole, at the key or pivotal point of the gorge. Several such charges can be distributed at various points in the gorge and connected and fired electrically. If the first blast does not start the gorge, the same process should be repeated with increased charges until it gives way.

To break up floating ice so that it will not bank up, forming a gorge, charges of dynamite can be exploded on the surface of the ice, the size of the charge depending on the thickness of the cakes. If the blocks of ice are large it may be necessary to get on the ice from the shore or boats and explode successive charges of several cartridges each with fuse and blasting cap, until the ice cake is properly broken.

If the stream is narrow the charge of explosives can be thrown on the ice from the shore, or, if the current is too swift, the charge can be

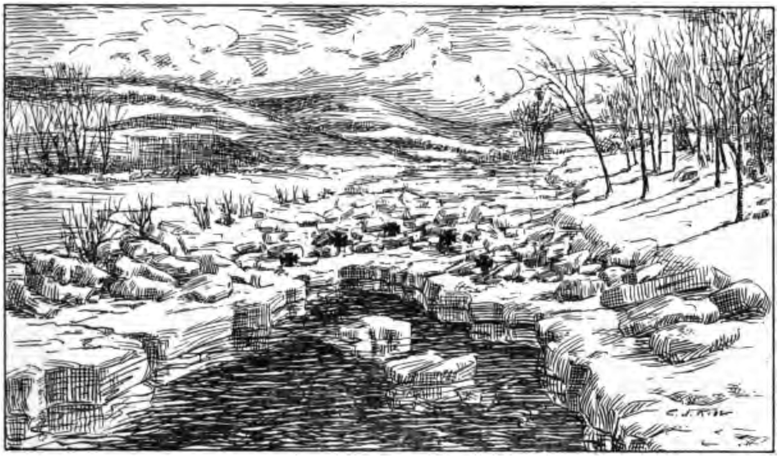


FIG. 75. DIAGRAM SHOWING LOCATION OF ROW OF HOLES FOR BLASTING AN ICE GORGE.

dropped on the floating cakes from the down-stream side of bridges. The dynamite should be tied in a bundle and one cartridge in each bundle primed with a blasting cap and fuse. A block of wood or stone can be tied to the charge as an anchor to prevent its rolling off the cake of ice. The fuse should be lighted before being thrown and ample length allowed for a getaway. Fuse burns about two feet per minute, and from two to three feet of fuse is usually sufficient. The place where the fuse enters the blasting cap should be sealed with du Pont Cap Sealing Compound or smeared with soap or grease to protect the charge in the cap from water.

Watering places for stock along the banks of streams can be easily kept free from ice in winter by the use of a little dynamite from time to time.

## Digging Ponds

The growing interest in fish culture, one of the moves to provide a toothsome substitute for expensive meats, gives rise to the digging of fish ponds. It is often desired also to make ponds for ducks and bathing pools in streams. Care must be taken not to crack the subsoil.

Fish ponds are generally located in low, wet lands where blasting has a great advantage over other methods of digging. The methods of blasting are exactly the same as for ditching (see pages 70 to 80). It is usually best

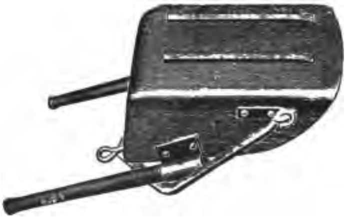


FIG. 76. DRAG SCRAPER SUITABLE FOR MOVING BLASTED GROUND IN FINISHING FISH PONDS, GRADING ROADS, FILLING GULLIES, AND MANY OTHER CLASSES OF WORK.

to dig the ponds quite long and not more than 25 feet wide, as there is much difficulty in shooting the soil out of wider ponds. When a greater width is desired, a part of the soil can be blasted out and the rest removed by small drag scrapers (Fig. 76). The same methods are used for digging in ice as in land.

**EXPLOSIVES cannot be shipped by parcel-post or express, nor can they be transported on a train carrying passengers for hire.**

**EXPLOSIVES MUST BE SHIPPED BY FREIGHT.**

## GENERAL PRECAUTIONS TO BE OBSERVED WITH REGARD TO EXPLOSIVES

DON'T forget the nature of explosives, but remember that with proper care they can be handled with comparative safety.

DON'T smoke while you are handling explosives, and DON'T handle explosives near an open light.

DON'T shoot into explosives with a rifle or pistol, either in or out of a magazine.

DON'T leave explosives in a field or any place where animals can get at them. Cattle like the taste of soda and saltpeter in explosives, and the other ingredients would probably make them sick or kill them.

DON'T handle or store explosives in or near a residence.

DON'T leave explosives in a wet or damp place. They should be kept in a suitable, dry place, under lock and key, and where children or irresponsible persons cannot get at them.

DON'T explode a charge to chamber a bore hole and then immediately reload it, as the bore hole will be hot, and the second charge may explode prematurely.

DON'T do tamping with iron or steel bars or tools. Use only a wooden tamping stick with no metal parts.

DON'T *force* a primer into a bore hole.

DON'T explode a charge before everyone is well beyond the danger zone and protected from flying débris. Protect your supply of explosives also from danger from this source.

DON'T hurry in seeking an explanation for the failure of a charge to explode.

DON'T drill, bore, or pick out a charge which has failed to explode. Drill and charge another bore hole at least two feet from the missed one.

DON'T use two kinds of explosives in the same bore hole, except where one is used as a primer to detonate the other, as where dynamite is used to detonate du Pont Low Powder. The quicker explosive may open cracks in the rock and allow the slower to blow out through these cracks, doing little or no work.

DON'T use frozen or chilled explosives. Dynamites other than the low-freezing ones often freeze at a temperature between 45° and 50° F.

DON'T use any arrangement for thawing dynamite other than one of those recommended by the du Pont Company.

DON'T thaw dynamite on heated stoves, rocks, bricks, or metal, or in an oven, and don't thaw dynamite in front of, near, or over a steam boiler or fire of any kind.

DON'T take dynamite into or near a blacksmith shop or near a forge on open work.

DON'T put dynamite on shelves or on anything else directly over steam or hot-water pipes or other heated metal surface.

DON'T cut or break a dynamite cartridge while it is frozen, and don't rub a cartridge of dynamite in the hands to complete thawing.

DON'T heat a thawing house with pipes containing steam under pressure.

DON'T place a hot-water thawer over a fire, and never put dynamite into hot water or allow it to come in contact with steam.

DON'T allow thawed dynamite to remain exposed to a low temperature, but use as soon as possible.

DON'T allow priming (the placing of a blasting cap or electric blasting cap in dynamite) to be done in a thawing house.

DON'T prime a dynamite cartridge, or charge or connect bore holes for electric firing during the immediate approach or progress of a thunder storm.

DON'T carry blasting caps or electric blasting caps in your pocket.

DON'T tap or otherwise investigate a blasting cap or electric blasting cap.

DON'T attempt to take blasting caps from the box by inserting a wire, nail, or other sharp instrument.

DON'T try to withdraw the wires from an electric blasting cap.

DON'T fasten a blasting cap to the safety fuse with the teeth or by flattening it with a knife; use a cap crimper.

DON'T keep electric blasting caps, blasting machines, fuse or blasting caps in a damp place.

DON'T attempt to use electric blasting caps with the regular insulation in very wet work. For this purpose secure du Pont Waterproof Electric Blasting Caps.

DON'T worry along with old, broken leading wire or connecting wire. A new supply won't cost much and will pay for itself many times over.

DON'T handle safety fuse carelessly in cold weather, for when cold it is stiff and breaks easily.

DON'T store or transport blasting caps or electric blasting caps with high explosives.

DON'T store safety fuse in a hot place, as this may dry it out so that uncoiling will break it.

DON'T lace safety fuse through dynamite cartridges. This practice is frequently responsible for the burning of the charge.

DON'T operate blasting machines half-heartedly. They are built to be operated with full force. They must be kept clean and dry.

DON'T cut the safety fuse short to save time. It is a dangerous economy.

DON'T expect a cheap article to give as good results as a high-grade one.

DON'T expect explosives to do good work if you try to explode them with a detonator weaker than a No. 6 (red label).

DON'T leave detonators exposed to the direct rays of the sun.

DON'T leave detonators where the rays of the sun will strike them after passing through glass.

DON'T have matches about you while handling explosives.

DON'T store explosives so that the cartridges stand on end.

DON'T open cases of explosives in a magazine.

DON'T open cases of explosives with a nail puller, pick, or chisel.

DON'T prime both ends of a cartridge when making primers of half cartridges, with a blasting cap or electric blasting cap, before cutting it in two. Cut the cartridge in half and prime each piece separately.

DON'T use a needle of iron or steel when firing by means of miners' squibs. Use one of copper or brass.

DON'T keep blasting caps or electric blasting caps in the same box or container with other explosives in the field. Keep them separate.

# We Want the Readers of this Book to have a Clearer Understanding of the History, Aims and Products of the du Pont Company

Its accomplishments during a century of public service are worthy of record and make a history of interest to every American.

The reasons for its entrance into new, though closely related, fields of commercial endeavor clearly define the functions of the du Pont Company in the industrial life of the country. This is a story which brings out the important work of the Chemical Engineer, whose contributions to science have advanced civilization immeasurably since your great-grandfather's day.

* * * * *

The first du Pont came to America from France in 1800, a political refugee. He was one of the foremost chemists of his time, a student of Lavoisier, the most famous chemist of his day. He came to the democratic Jefferson with a practical idea—a means of preserving to mankind the boldest experiment ever made by a Government, the United States of America.

President Jefferson recognized the services that this first du Pont could render to our new Republic. He received him and counseled with him and officially helped him in establishing on the banks of the Brandywine Creek the first powder mill in America. Thus Eleuthere Irénée du Pont became powder maker to the United States Government. And succeeding generations have well preserved that tradition.

It was a few years later that Perry won his famous victory on Lake Erie—one of the most inspiring deeds in the history of our Navy—and the powder that repelled the invader, the ammunition that made Perry's victory possible, was sent post-haste in a prairie schooner from that little powder mill on Brandywine Creek.

That same spirit of service helped "Old Zach" Taylor in Mexico; it helped President Lincoln to keep the Union "One and indivisible"; it helped Dewey in Manila Bay and Funston in the Philippines. It went with a small band of courageous men to the walls of Peking, and it was that same spirit of service, that tradition founded in 1802 by two great believers in Democracy, that again helped to defeat Autocracy in five years of bitter toil from August, 1914, to November, 1918.

* * * * *

The service rendered by this Company to the cause of the Allies—and later to our own Government—is well illustrated by one small incident.

On being introduced to an officer of the Company in Washington during the past war, General Hedlam, representative of the British Government, exclaimed, "Please let me shake your hand again, sir, and permit me to say to you that the du Pont Company is entitled to the credit of saving the British Empire!"

The task which the Company faced during the World War called for increasing its capacity in the space of a few short months from 12,000,000 pounds of smokeless powder a year to 440,000,000 pounds a year.

There is an interesting fact that goes with this gigantic undertaking:

At the beginning of the war, we sold powder to the Allies at $1.00 a pound. By November, 1915, powder was priceless, yet the du Pont Company reduced the price to 80c—and in July, 1916, reduced the price again to 60c. In April, 1917, when the United States entered the war, our price was further reduced to 47½c a pound.

Through those years, the Company supplied 40% of all explosives used by the Allied Armies and Navies and, during that period, voluntarily reduced the price by over 50%.

* * * * *

The history of the Company as a defender of our country in times of war is inspiring and dramatic. War, thank God, comes but seldom. These instances referred to, merely tell how great emergencies were met—they are but "high-lights" in the long record of service rendered day-in and day-out during the normal years of peace—for the service of peacetime industry is, of course, the foundation on which the du Pont Company is built.

For 120 years du Pont explosives have been an important factor in the development of the nation. They have released the ores from the mines for the service of our basic industries, supplied the coal to keep the wheels of factories turning and to bring warmth to our homes, blasted the way through forest and mountain for our network of railroads, cleared and drained waste lands so that the farmer may grow larger crops.

We have met the peace demands of a busy and growing country without fail, striving always to supply more efficient explosives and safer explosives—at less cost. The peace history of the du Pont Company as well as the war history of the du Pont Company is in close parallel to the history of the United States.

* * * * *

These are just a few incidents in the history of the du Pont Company that we want the readers of this book to know.

* * * * *

Far more important, however, as a point of interest and as the key for a clear understanding of the du Pont Company and its products, is *the reason for the present du Pont family of diversified products, and the reason for their outstanding quality and reasonable cost.*

*Each product which bears the du Pont oval is a product developed through chemistry*—either made from the same basic materials or through applications of similar chemical control in manufacturing processes.

Each du Pont product is the result of chemical research and applied chemical knowledge—developed to its present high standard and reasonable cost through the work of du Pont Chemical Engineers.

The work of the Chemical Engineer during the past century has advanced civilization by ten centuries!

* * * * *

He has brought to mankind comforts and conveniences that a century ago were only wishes.

He has bared the secrets of Nature and laid at the feet of the world's industries new substances, new uses for them, new ways of using the present materials of commerce in satisfying man's wants.

He has helped pack hours into minutes! Working miracles with metals he has made possible the wonders of today's time-saving transportation; . . . the mile-a-minute locomotive, the cross-country truck, the racing motor, the airplane. He has helped produce the telephone, telegraph and wireless, and thus cut the time of communicating with other people to the merest fraction of what it was a century ago. His applications of chemistry to inks, colors and papers have made possible books, magazines, newspapers, publications that reach millions in the time your great-grandfather took to reach a few scores of people.

His paints, varnishes and enamels have placed beauty beyond Time's destroying hands. His movie films flash the world before you and his phonograph records immortalize Caruso's voice for your children's children.

His visions have crowded the highways of commerce. By applying the discoveries of chemistry in a practical way he has intensified the world's production, lowered costs and driven the carriers of commerce to the far corners of the earth, seeking the raw materials industry needs, or carrying to markets its finished goods.

Into your home he has brought a wealth of comforts. Examine the room you are sitting in, its furnishings and fittings, and with that picture in your mind, try to imagine the same room in your great-grandfather's day. Quite a difference in the two rooms. In yours are comforts and conveniences your great-grandfather never wished for, they were unthought of during his day. Yet this great change in life has come only during the past century, and it is the Chemical Engineer, who, more than any other, has wrought this difference in the surroundings of life and brought into your home a wealth of comforts.

* * * * *

The du Pont organization, which for 120 years has been building on this foundation of applied chemistry, takes no little pride in the contributions that du Pont engineers have made in the development of the industry in the United States . . . and in the work of du Pont Chemical Engineers lies the reason for the present du Pont family of products, widely different in appearance and use, yet closely related as to every other point of manufacture.

The founder of the du Pont Company, Eleuthere Irénée du Pont de Nemours, was himself a chemist, and the making of explosives, even in his day, called for the services of a chemist. As dynamite was invented and other high explosives came into use, increasingly higher types of chemical knowledge of explosives were needed. So it was only natural that in the early years of this century, the du Pont Company aimed to have a very extensive chemical staff.

It was a staff of Chemical Engineers, men who knew manufacturing as well as chemistry, and so in the course of research looking to the improvement of du Pont explosives, they came upon other products, alike in their chemical structure, that might be manufactured from the same or similar basic materials or by machinery and process with which the du Pont Company was familiar.

You find the du Pont oval on the *explosives* which release the ores needed by industry and the fuel to keep you warm; which blast paths through mountains and forests for your roads; which clear and drain your land for larger crops; which aid you in planting your orchards, bringing you better fruit and quicker yields.

You find the du Pont oval on the labels of *paints*, *varnishes*, *enamels*, *lacquers*—a complete line of such products to beautify and protect your home, your car, your furniture, etc.

It identifies the exquisite articles of *Pyralin* toiletware that adorn your wife's dressing table.

It is stamped upon rolls of *Fabrikoid* used for upholstering or topping your automobile, in making your luggage, in binding your books and in many other articles that you use.

The *dyes* used in making your clothing, your curtains, your blankets, very probably were shipped in containers bearing the du Pont oval.

The *fertilizers* you use to advance and increase your crops; the *disinfectants* you use to keep your home sanitary; the *medicines* which safeguard your health, most likely contain du Pont chemicals.

When you go hunting or trapshooting, the name Du Pont or Ballistite on the carton and top-shot wad of your shotgun shells tells you that you are shooting the finest *smokeless powder* made—and insures safety and accuracy.

The du Pont oval appears on this seemingly unrelated family of products because of the ability of du Pont Chemical Engineers who have been able to utilize the chemical knowledge or the basic raw materials that we need in our prime industry—the making of explosives—in making these articles that the du Pont Company feels are of value and service in other industries and to the public.

This family of products maintains the tradition established over a century ago by Eleuthere Irénée du Pont de Nemours, first powder maker to the U. S. Government—the protection of the nation.

For the manufacture of these products allows the du Pont Company to erect a machine that, in times of our country's peril, can be diverted to the production of explosives and other munitions of war. It is through the production of these normal products of peace that we can maintain not only this machine, so essential to our country's safety, but also an organization of the best chemical minds we can find—an organization always busy in working out new processes, developing new materials, developing new uses for present materials, making new forms out of useless ones, ever seeking to increase quality and reduce costs.

* * * * *

In the future—and now we can only glimpse it—the du Pont Company hopes to contribute, as it has in the past, but in increasing measure, to the comfort, the security and the prosperity of the American home and American industry.

## These are the principal products manufactured by

# E. I. du Pont de Nemours & Co., Inc.

### and identified by the du Pont Oval

DU PONT

Every du Pont Product is a product of chemistry—made either from the same basic materials, or through application of similar chemical processes—the result of chemical research and applied chemical knowledge,—developed to its present high standard through the work of du Pont Chemical Engineers.

## Explosives

A complete line of high explosives and blasting powder for every industrial and agricultural need.

Ore Mining
Coal Mining
Quarrying
Road Building
Contracting
Lumbering
Land Clearing
Ditching
Tree Planting
Subsoiling
Blasting Accessories.

## Sporting Powders

Smokeless Shotgun Powders:
Du Pont (bulk)
Ballistite (dense)
Schultze (bulk)
Black Powders
Rifle and Pistol Powders
Explosives for Military Uses.

## Pyralin

Ivory Pyralin, Shell Pyralin,
Amber Pyralin Toiletware
Pyralin Sheeting, Rods and Tubes
Transparent and in hundreds of colors and color combinations.
"The material of a thousand uses."

## Chemical Products

Pyroxylin Lacquers and Enamels
for finishing and preserving
wood and metal surfaces.
Solutions for Coating Leathers
Du Pont Household Cement
Bronze Powder
Ether

## Paints and Varnishes

A complete line of paints, varnishes, enamels and stains for every requirement of home, farm, office, factory, railroad and ship.

Pigments and Colors
for paint, ink, rubber and paper manufacturers.

## Fabrikoid

A coated textile made in a wide variety of leather-like and other grains and colors for—

Furniture Upholstery
Automobile Upholstery and Tops
Luggage
Novelties
Bookbinding
Trunks
Window Shades
Box and Case Coverings
and many other purposes.

---

Rubberized Auto Top Material
Ventube (Mine ventilation tubing)
Minefab (Mine concentration table covering)
Waterproof Cloth for Sport Clothing
Hospital Sheeting

## Dyestuffs

A line comprising hundreds of dyes has been developed to serve the textile, leather, paper and other industries depending on dyestuffs.

## Chemicals

Commercial Acids and Chemicals essential for most American industries.

Alum for water purification. Nitrate of Soda, Saltpetre, etc., for fertilizers. Pharmaceutical products, etc., etc.

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DU PONT

# EXPLOSIVES

## For Industrial Uses

Dumorite, Red Cross Extra and Gelatin Dynamites,
du Pont Extra, Gelatin and Straight Dynamites,
Repauno Gelatin, du Pont Blasting Gelatin,
Du Pont R. R. P., Permissible Explosives
Blasting Powders

## For Agricultural Uses

Dumorite
Red Cross Extra
Repauno Stumping
Pacific Stumping
Du Pont Stumping
Du Pont Straight
Red Cross Farm Powder

**Sporting and Military Powders**

**Blasting Accessories**

**Charcoal, Wood Pulp, Wood Oil, Recovered Salt,
Refined Nitrate of Soda**

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Send for descriptive booklets and price lists relating to the selection and usage of products listed

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**E. I. DU PONT DE NEMOURS & CO., Inc.**
***Explosives Department, Sales Division***
**WILMINGTON, DELAWARE**

DU PONT

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Spokane, Wash.
Springfield, Ill.

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